Figure 3.11 Average Annual Influent Loading Rate at the Pease Wastewater Treatment Facility

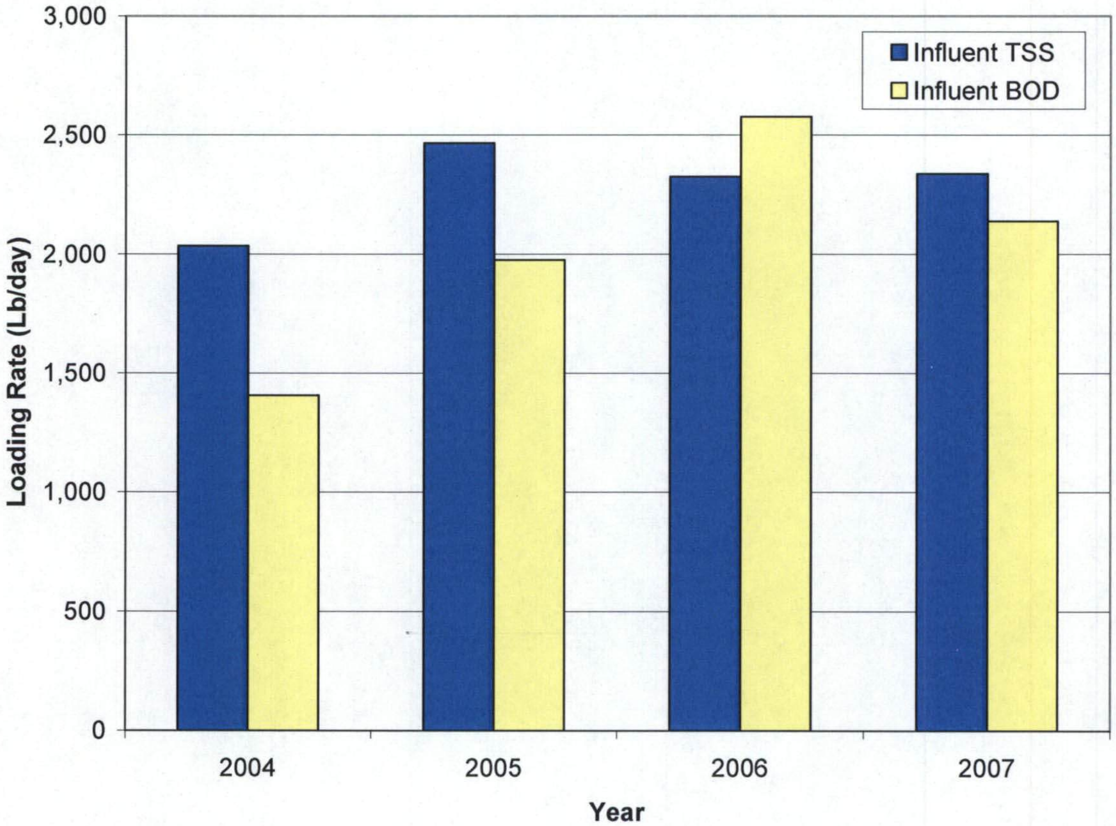


Table 3.6 Average Annual Influent Loading Rates at the Pease Wastewater Treatment Facility

Year	Load (Lb/d)	
	BOD	TSS
2004	1,406	2,035
2005	1,977	2,466
2006	2,577	2,325
2007	2,137	2,337

Historical influent nitrogen data for the Pease WWTF was limited due to changes in influent nitrogen sampling and analysis procedures at the WWTF. In 2005, influent wastewater was analyzed for total Kjeldahl nitrogen (TKN), which determines the combined concentration of organic nitrogen and ammonia. However, since December 2007 influent samples have been analyzed for a modified total nitrogen concentration that includes ammonia, nitrate, and nitrite, but not organic nitrogen compounds. These data represent essentially the total inorganic nitrogen concentration entering the WWTF. Based on these data, the following ranges were determined:

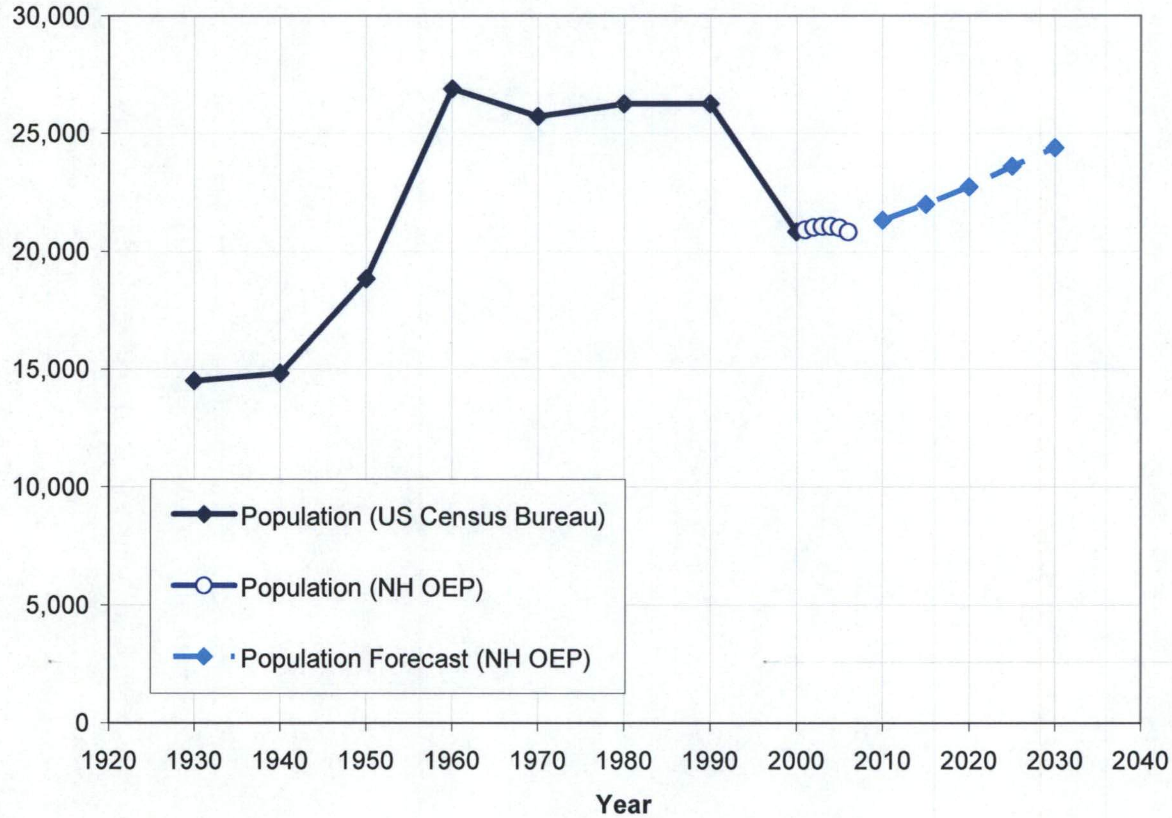
- Influent concentrations
  - TKN (organic N, ammonia): 10 to 71 mg/L
  - Total inorganic nitrogen (ammonia, nitrate, nitrite): 21 to 76 mg/L
- Influent loading
  - TKN: 89 to 379 lbs/day
  - Total inorganic nitrogen: 148 to 457 lbs/day

It is assumed that the highest measured total inorganic nitrogen measured (457 lb/days) is a reasonable estimated of the total average daily nitrogen loading. Although a conservative approach, it is assumed that using this maximum value will yield an overestimate that may account for the organic nitrogen load that would be included in an average of actual total nitrogen loading to the WWTF. These data and the assumptions will be revisited once additional nitrogen data is collected at the WWTF.

3.4. Population and Employment Forecasts

Population and employment forecasts provide the basis for developing the wastewater flow and load forecasts. Population forecasts were provided by the New Hampshire Office of Energy and Planning (NH OEP). The forecasts extend to the year 2030. The forecasts are shown in Figure 3.12 along with historic population data. The population peaked at 26,900 in 1960 and remained above a level of 25,000 people until the 1990s. The decline in the 1990s is due to the closing of the Pease Air Force Base. The population data from the NH OEP indicates that the population has remained fairly steady since 2000.

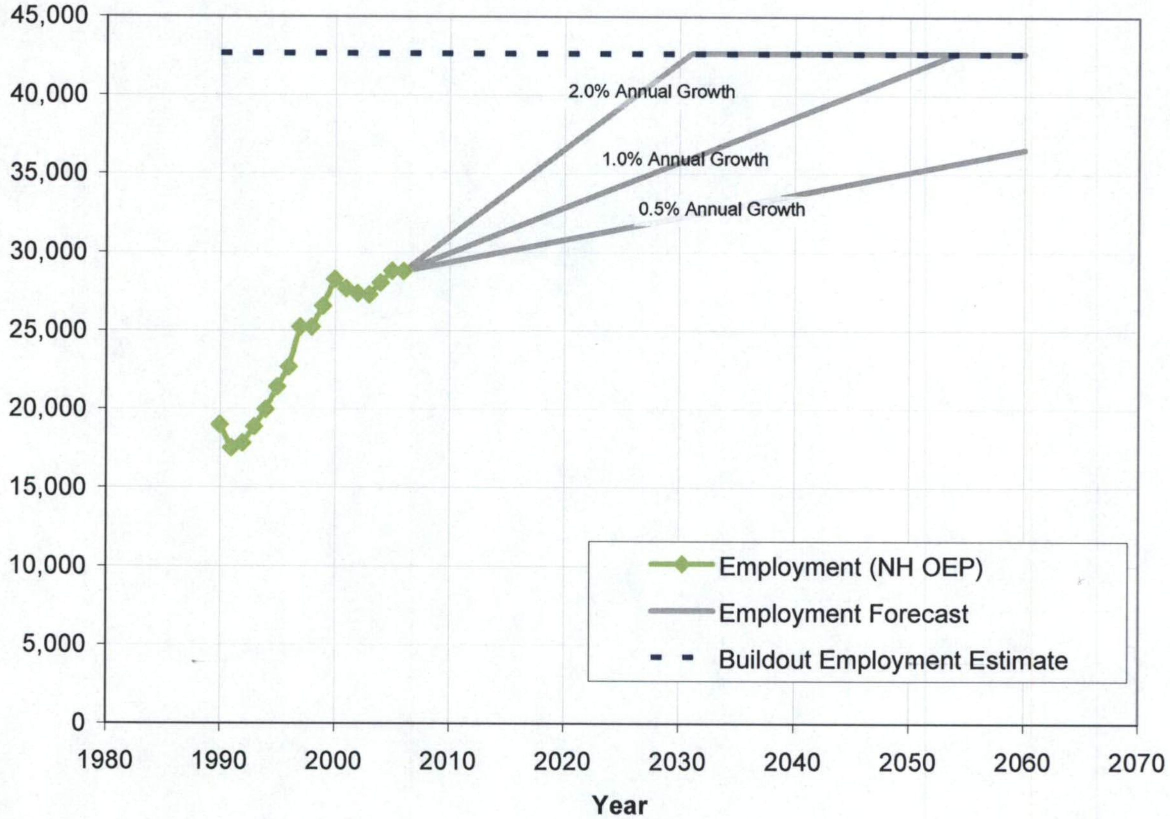
Figure 3.12 City of Portsmouth Historical and Forecasted Population



Employment forecasts for the City of Portsmouth were not available from NH OEP or any other planning agencies. There is a significant potential for growth in employment in Portsmouth (see Section 3.5). As a result, the employment forecast could have a strong impact on the wastewater flow and load forecasts.

With no forecasts available from planning agencies, low, medium, and high employment growth forecasts were developed. Under the low growth scenario, employment grows at 0.5 percent annually. The employment grows at 1.0 percent and 2.0 percent annually under the medium and high growth scenarios, respectively. The forecasts along with historic employment data are shown in Figure 3.13.

Figure 3.13 City of Portsmouth Historical and Forecasted Employment



The population and employment in the years 2000, 2006 and in the forecast years is shown in Table 3.7.

Table 3.7 City of Portsmouth Historic and Forecasted Population and Employment

Demographic	Year							
	2000	2006	2010	2020	2030	2040	2050	2060
Population	20,825 (1)	20,811 (2)	21,320 (2)	22,730 (2)	24,390 (2)	25,881 (3)	27,373 (3)	27,450 (3)
Employment	28,258 (2)	28,768 (2)	29,343 (4)	30,782 (4)	32,220 (4)	33,659 (4)	35,097 (4)	36,535 (4)
			29,919 (5)	32,796 (5)	35,672 (5)	38,549 (5)	41,426 (5)	44,239 (5)
			31,069 (6)	36,823 (6)	42,577 (6)	42,653 (6)	44,239 (6)	44,239 (6)

Notes:

1. Source: United States Census Bureau
2. Source: New Hampshire Office of Energy and Planning
3. Assumes the average growth rate of the New Hampshire Office of Energy and Planning forecasts continues beyond 2030 until reaching the buildout population of 27,450 (see Section 3.5) in the year 2051.
4. Low growth employment forecast: 0.5% annual growth rate.
5. Medium growth employment forecast: 1.0% annual growth rate. Employment reaches buildout level of 44,239 in the year 2054.
6. High growth employment forecast: 2.0% annual growth rate. Employment reaches buildout level of 44,239 in the year 2031.

3.4.1. Buildout Population and Employment Forecasts

The buildout analysis estimated the maximum allowable density of development in the City. As noted earlier, the Capacity Assurance Planning Environment (CAPE) model was used to perform the analysis.

3.4.1.1. Undevelopable/Developable Area

The buildout analysis assumes that there are portions of the City in which future growth is restricted. For convenience, these areas are referred to as undevelopable areas even though there may already be some existing development. The undevelopable areas are defined as follows:

- Areas within 100 feet of freshwater bodies
- Areas within 50 feet of high tide mark north of Little Harbor
- Areas within 100 feet of high tide mark south of Little Harbor
- Conservation lands
- Cemeteries

+ historic sites? archaeological sites..

The undevelopable area within the City of Portsmouth is shown in Figure 3.14.

3.4.1.2. Buildout Population

For areas zoned residential, the buildout population is estimated by performing the following steps for each parcel:

1. Determine the maximum number of lots that a parcel can be subdivided into
2. Multiply the number of lots by the number of people per household at buildout

The maximum number of lots that a parcel can be subdivided into is determined by the parcel's developable area and the minimum lot size required by zoning regulations. Table 3.8 shows the minimum lot size for each of the residential zoning districts.

Table 3.8 Minimum Lot Size for Residential Zoning Districts

Zoning	Description	Minimum Lot Size (square feet)
SRA	Single Residence A	43,560
SRB	Single Residence B	15,000
GRA	General Residence A	7,500
GRB	General Residence B	5,000
GA/MH	Garden Apartment/Mobile Home	10,000
A	Apartment	3,500
R	Rural Residential	217,800
MRO	Mixed Residential Office	7,500
MRB	Mixed Residential Business	7,500

Source: City of Portsmouth Zoning Ordinance (December 1995)

City of Portsmouth, New Hampshire

Wastewater Master Plan

Technical Memorandum

TM 3

FLOWS AND LOADS – EXISTING AND FORECASTED CONDITIONS

Tasks:	3.1 through 3.5	
Status:	~~First Draft~~ **Submitted to EPA / DES**	~~4/16/08~~ **4/29/08**

3.1. Introduction and Purpose

This Technical Memorandum (TM) was prepared to satisfy the requirements of Task 3 as set forth in the Work Plan for the City of Portsmouth, New Hampshire Wastewater Master Plan (WMP). This TM evaluates flows and loads under existing and forecasted conditions. Further, the potential for additional septage, biosolids, and fats, oil and grease (FOG) handling capacity is also evaluated. Each task associated with Task 3 of the Work Plan is addressed below.

The loads analyzed by this WMP include biological oxygen demand (BOD), total suspended solids (TSS), and total nitrogen. The National Pollutant Discharge Elimination System (NPDES) Permit for the City's two wastewater treatment facilities (WWTFs) regulates the treatment and discharge of both of these as well as other pollutants.

The flow and load forecasts presented in this TM were developed primarily to estimate future wastewater treatment and disposal needs. To this end, the flows and loads will be discussed in terms of City-wide contributions, or contributions specifically to the Peirce Island or Pease WWTF. In the future, the flow forecasts will be revisited as additional flow meter data becomes available throughout the collection system.

A software package developed by Brown and Caldwell, the Capacity Assurance Planning Environment (CAPE) model, was used to assist with the development of the wastewater flow and load forecasts. CAPE is GIS-based application developed for wastewater master planning. It performs tasks such as estimating population and employment distributions, developing buildout forecasts, analyzing water usage data and performing wastewater forecasts.

3.1.1. Planning Horizon and Study Area

The period of time over which a study evaluates conditions is known as its planning horizon. Working within an established planning horizon ensures that decisions made today take into account the needs of tomorrow and result in solutions that are scalable and sustainable in the long-term.

Different planning horizons have been identified for different types of infrastructure and their expected useful lives. The planning horizon for the WWTFs extends to the year 2030 which is approximately a 20 year planning period. Additionally, the WWTF sites will be evaluated for sustaining flow based expansions through the year 2060. The planning horizon for the collection system infrastructure extends through the year 2060 which is approximately a 50 year planning period.

In addition to looking at conditions through 2030 and 2060, the WMP also analyzed the maximum level of development expected in the City. This level of development is referred to as "buildout" conditions. Buildout conditions were used to evaluate the potential for growth in the City and to ensure that planned infrastructure would be properly sized for all future conditions.

The Study Area has been divided into several categories based on categories of wastewater service.

Sanitary Sewer Service

The Sanitary Sewer Service area includes the City of Portsmouth and the following communities which currently discharge wastewater to the Portsmouth wastewater collection system: Greenland, Newcastle, and Rye. It also includes the following communities which may discharge to the City's system in the future: North Hampton, Stratham, Newington, and Pease Development Authority which oversees activities at the Pease International Tradeport.

Only a small portion of Greenland is currently served. This service is provided through a private agreement with the property owner in Greenland and not via an inter-municipal agreement between Greenland and Portsmouth.

Rye has an inter-municipal agreement with Portsmouth for sewer service.

Based on past studies, the Route 1 corridor in North Hampton may require sewering to the Hampton border at some time in the future.

Biosolids Handling

The Biosolids Handling Service Area includes the City of Portsmouth and potentially all 44 communities in the Seacoast Regional Wastewater Management Study, as well as select WWTFs in Maine, including Kittery, York and South Berwick.

Fats, Oils and Grease

The FOG Service Area includes the City of Portsmouth and potentially all 44 communities in the Seacoast Regional Wastewater Management Study.

Septage

The Septage Service Area includes the City of Portsmouth and potentially all 44 communities in the Seacoast Regional Wastewater Management Study.

3.2. Review of Historical Flows and Loads

Historical flow and loads data were collected and analyzed. This data will be used in Section 1.7 to calibrate the wastewater flow and loading rates for the forecasting model.

3.2.1. Wastewater Treatment Facilities

This section presents the historical flows and loads for the Peirce Island and Pease WWTFs.

3.2.1.1. Flows

Influent flow data to the WWTFs was collected from monthly operating reports. The data is presented in the sections that follow.

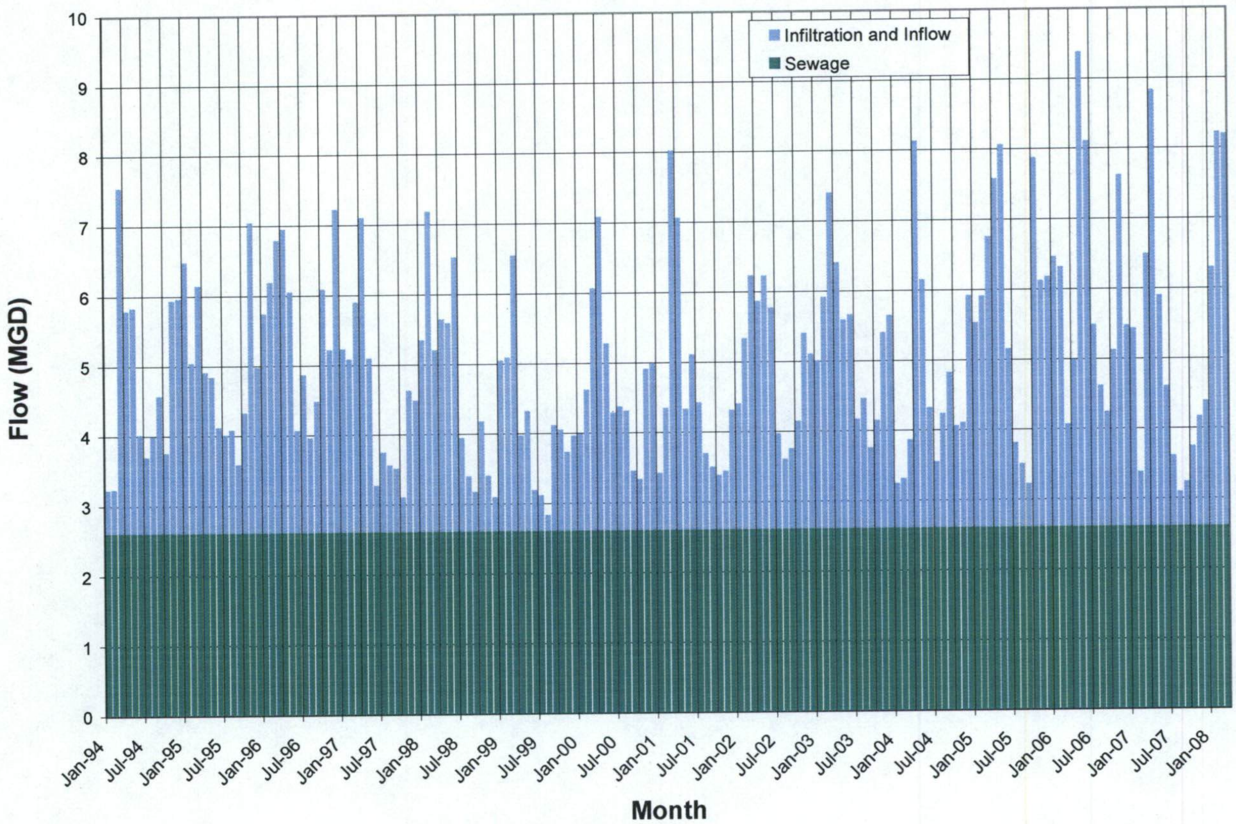
Peirce Island Wastewater Treatment Facility

Flow records dating back to 1994 were collected for the Peirce Island WWTF. The average monthly flow at the Peirce Island WWTF is shown in Figure 3.1. As shown in the Figure, the flows have been disaggregated into sanitary flow and an infiltration and inflow (I/I) components. The disaggregation was performed after analyzing the data and determining that the sanitary flow component is roughly 2.6 MGD and that it has not changed significantly over the last 14 years1. The I/I component was estimated by subtracting the sanitary flow component from the total measured flow. The I/I component includes combined flows with the exception of that which are discharged through the City's permitted combined sewer overflows (CSOs). The combined flows discharged from the CSOs are not shown in the figure.

The average annual flow at the Peirce Island WWTF is shown in Figure 3.2. As with Figure 3.1, the flows have been disaggregated into sanitary flow and I/I components. The average annual flows are also provided in Table 3.1.

[1] The lowest average daily flow during 2007 was 2.6 MGD. This low flow value occurred on several days in early September. The 30-day running average flow during this period of time was one of the lowest values during the 14 years of available data. It is assumed that I/I was virtually non-existent during this time and that the measured flow is a reasonable estimate of the sanitary flow.

Figure 3.1 Average Monthly Flow at the Peirce Island Wastewater Treatment Facility(1)



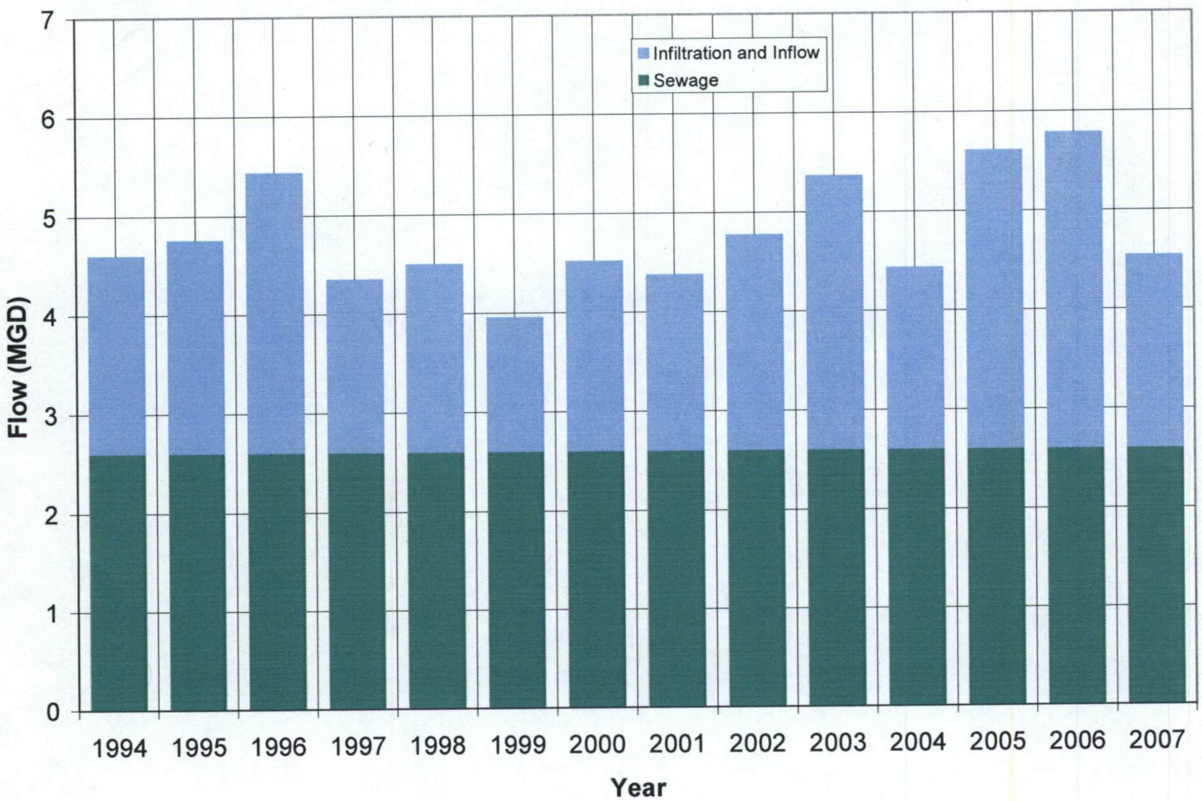
Notes:

1. Sanitary flow component estimated to be 2.6 MGD. I/I estimated by subtracting sanitary flow component from total measured flow and includes combined flows with the exception of combined flows discharged from the permitted CSOs.

Table 3.1 Average Annual Flow at the Peirce Island WWTF

Year	Flow (MGD)
1994	4.80
1995	4.96
1996	5.64
1997	4.56
1998	4.71
1999	4.16
2000	4.72
2001	4.59
2002	4.98
2003	5.57
2004	4.64
2005	5.81
2006	5.99
2007	4.75

Figure 3.2 Average Annual Flow at the Peirce Island Wastewater Treatment Facility(1)



Notes: 1. Sanitary flow component estimated to be 2.6 MGD. I/I estimated by subtracting sanitary flow component from total measured flow and includes combined flows with the exception of combined flows discharged from the permitted CSOs.

I/I can vary significantly depending upon hydrologic conditions. In order to determine the range and likelihood of different levels of I/I occurring in the collection system, a statistical analysis was performed.

The likelihood (or probability) that a certain I/I flow will be exceeded is referred to as its return period and is often expressed in years. The goal of the statistical analysis is to determine the return period for different levels of flow. For example, a 10-year peak month flow is the average monthly flow which is exceeded once every 10 years on average. The probability that the flow will be exceeded in any given year is determined by taking the inverse of the return period. For example, the 10-year peak month flow has a 10% chance of being exceeded once every 10 years.

Understanding the likelihood of certain flows occurring in the collection system and at the WWTPs is an essential component of risk-based design. For example, a WWTP with a NPDES maximum monthly flow limit equal to the 10-year peak month flow would be expected to exceed the flow-based permit limit once every 10 years on average[2].

The statistical analysis was performed on the I/I component of the wastewater flow. It evaluated the maximum average annual and maximum monthly I/I. The statistical analysis was performed in accordance with the standards developed and employed within the hydrologic community for analyzing extreme events (i.e., floods and droughts).

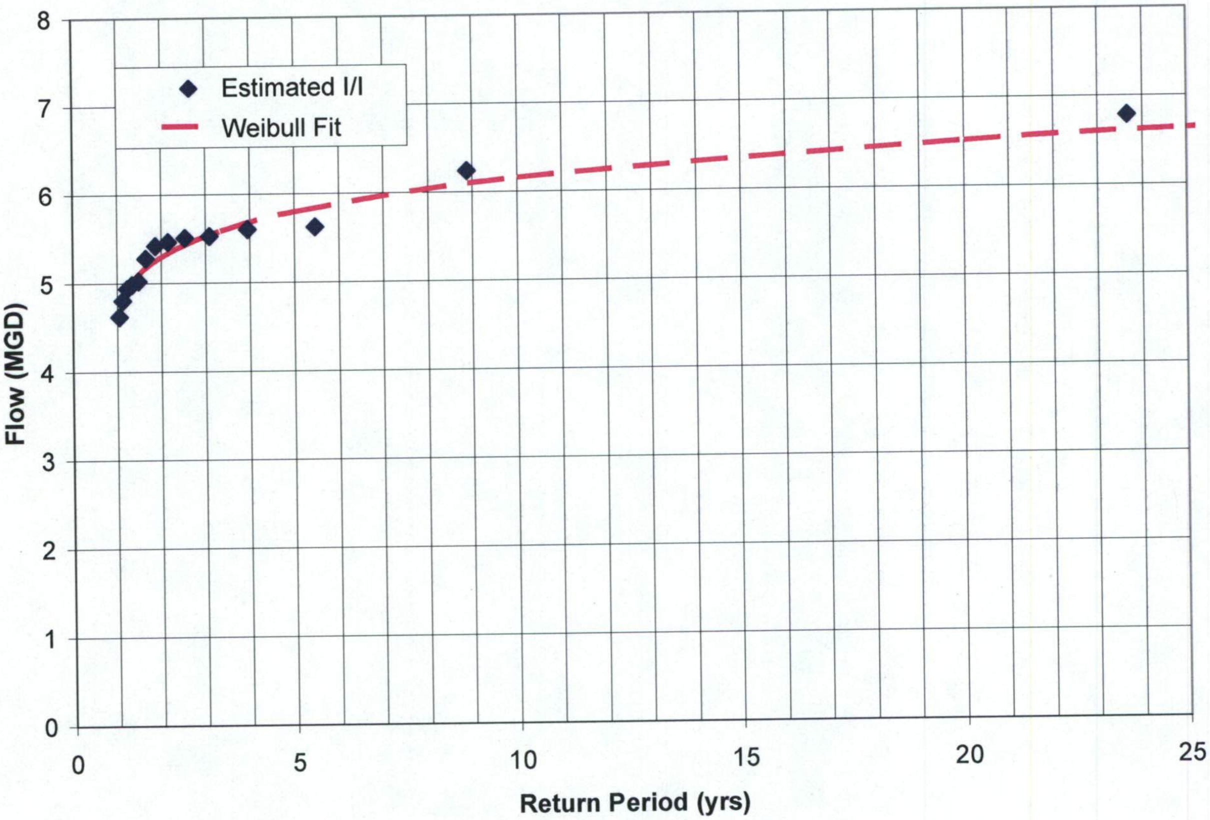
In the first step of the statistical analysis a probability distribution is fit to the largest average annual and maximum monthly I/I. A number of probability distributions have been developed and used extensively for characterizing high flow events by the hydrologic community. These distributions include the lognormal, Log-Pearson Type 3, and Weibull distribution. All three of these distributions returned similar results for the I/I at the Peirce Island WWTP. Due to its ease of implementation, the Weibull distribution was selected as the preferred distribution.

The maximum monthly I/I exceedance frequencies for the Peirce Island WWTP are shown in Figure 3.3. The return period shown along the x-axis indicates how often the flow is expected to be exceeded in years. The dashed line shows the return period based on the Weibull distribution. For comparison purposes, the maximum monthly I/I estimated from the WWTP measurements are also shown in the figure. The return period for these values was determined using another technique employed in hydrology called plotting position. There are a number of different plotting position techniques that have been developed. One of the most popular is the unbiased Cunnane plotting position. The Cunnane plotting position was used to plot the maximum month I/I estimated from the WWTP measurements.

The average annual infiltration and inflow recurrence frequencies are shown in Figure 3.4.

[2] Currently the Peirce Island WWTP must report average annual and monthly flows, but no limits have been set under the Interim Standards as set forth in the Administrative Order dated August 1, 2007.

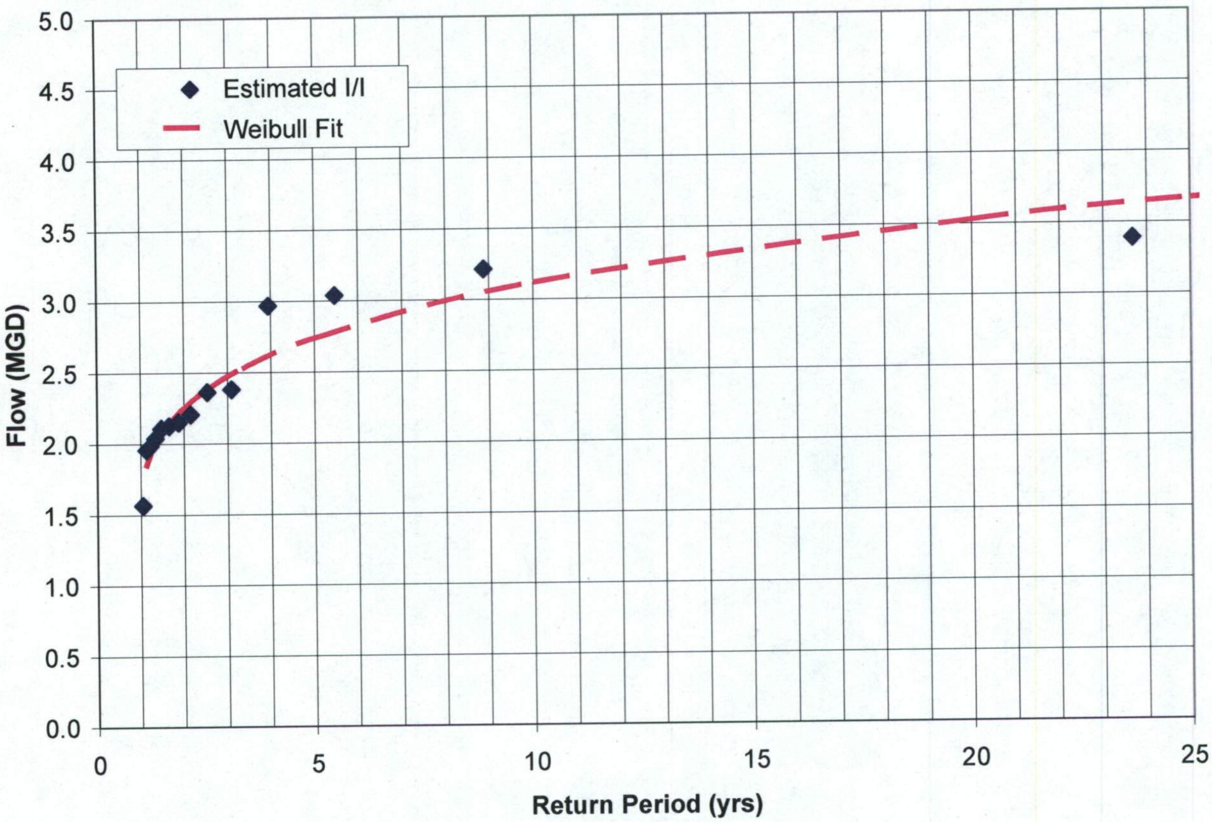
Figure 3.3 Peirce Island WWTF Maximum Monthly I/I Recurrence Frequencies (1)



Notes:

1. Results of statistical analysis of I/I to the Peirce Island WWTP (see Figure 3.1). The I/I values used in the analysis were estimated from flow measurements to the Peirce Island WWTP. A Weibull distribution was fit to the I/I values (dashed line). The I/I estimated from the WWTP measurements (blue diamonds) are plotted using the Cunnane plotting position.

Figure 3.4 Peirce Island WWTF Average Annual I/I Recurrence Frequencies (1)



Notes:
1. Results of statistical analysis of I/I to the Peirce Island WWTP (see Figure 3.2). The I/I values used in the analysis were estimated from flow measurements to the Peirce Island WWTP. A Weibull distribution was fit to the I/I values (dashed line). The I/I estimated from the WWTP measurements (blue diamonds) are plotted using the Cunnane plotting position.

The estimated 2, 5, 10, and 20-year flows at the Peirce Island WWTF are shown in Table 3.2. In addition to showing the I/I, the total flow (i.e., sanitary flow plus I/I) has also been included in the Table.

Table 3.2 Estimated Flow Recurrence Frequencies at the Peirce Island WWTF

Return Period (years)	I/I (MGD)		Sanitary flow Plus I/I (MGD)	
	Average Annual	Maximum Monthly	Average Annual	Maximum Monthly
2	2.3	5.3	4.9	7.9
5	2.7	5.8	5.3	8.4
10	3.1	6.2	5.7	8.8
20	3.5	6.5	6.1	9.1

Rye, Greenland, and Newcastle discharge wastewater to the City's collection system. Table 3.3 estimates how much wastewater is contributed by each community. The Table shows the sanitary flow and I/I components as well as the total flow. The values shown in Table 3.3 represent the I/I component with an estimated exceedance frequency once every 10 years.

Table 3.3 Peirce Island WWTF Flows by Source

Source	Flow (gallons/day)										
	Sanitary flow		I/I (1)						Total (Sanitary flow plus I/I)		
			Avg Annual		10 Year Exceedance Flow (2)				Avg Annual	10 Year Exceedance Flow (2)	
					Max Avg Annual		Max Month			Max Avg Annual	Max Month
Portsmouth	2,525,000		2,365,000	(1)	3,082,500	(1)	6,056,250	(1)	4,890,000	5,607,500	8,581,250
Rye	7,500	(3)	2,500	(3)	3,750	(4)	9,375	(5)	10,000	11,250	16,875
Greenland (7)	10,000		0		0		0		10,000	10,000	10,000
New Castle	67,500	(6)	22,500	(6)	33,750	(4)	84,375	(5)	90,000	101,250	151,875
Total (8)	2,600,000		2,390,000		3,120,000	(9)	6,150,000	(10)	4,990,000	5,720,000	8,750,000

Notes:

1. Includes combined flow with the exception of combined flows discharged as CSOs.
2. Flow likely to be exceeded once every 10 years on average (10% probability of exceedance in any given year).
3. Average annual flow is estimated at 10,000 gpd. Data was not available to develop a detailed estimate of the portion of the flow which is sanitary versus I/I. Using engineering judgment, it was assumed that 75% of this flow is sanitary flow.
4. Data was not available to statistically determine the 10-Year Max Average Annual I/I. Based on engineering judgment, it was assumed that the 10-Year Max Average Annual I/I is 1.5 times greater than the Average Annual I/I.
5. Data was not available to statistically determine the 10-Year Max Month I/I. Based on engineering judgment, it was assumed that the 10-Year Max Month I/I is 2.5 times greater than the 10-Year Max Average Annual I/I.
6. Average annual flow is estimated to be 90,000 gpd. Data was not available to develop a detailed estimate of the portion of the flow which is sanitary versus I/I. Using engineering judgment, it; assumed that 75% of this flow is sanitary flow.
7. Estimated average annual flow is 10,000 gpd; flow is discharged to a force main and is assumed to be all sanitary flow with no I/I component.
8. Total flow to the Peirce Island WWTF; values developed from data measured from 1994 - 2007.
9. See Figure 3.4.
10. See Figure 3.3.

Pease Wastewater Treatment Facility

Flows from 2004 through 2007 were collected for the Pease WWTF. The average monthly flows are shown in Figure 3.5 while the average annual flows are shown in Figure 3.6.

Wastewater flows to the Pease WWTF changed from 2004 through 2007 due to changes in the Pease Development Authority's industrial customer base. For example, there were several significant industrial expansions. As a result, it was difficult to estimate the variation in the base sanitary flow component during this time. Accordingly, the measured flows, as shown in Figures 3.5 and 3.6, were not disaggregated into sanitary flow and I/I components as they were for the Peirce Island WWTF flows as shown in Figures 3.1 and 3.2.

However, while no attempt was made to characterize the historic variation in sanitary flow, the current sanitary flow was estimated. Based on the monthly flow data from 2007, it is estimated that the current sanitary flow to the Pease WWTF is 410,000 gpd. The average annual flow for

2007 was 586,000 gpd. Accordingly, the average annual I/I for 2007 was approximately 176,000 gpd.

A statistical analysis of the I/I was not performed for the Pease WWTF. The statistical analysis requires many data points for the results to be reliable. For Peirce Island, the 14 years of historical data provided a solid foundation for the analysis. However, for the Pease WWTF, the uncertainty in the historical sanitary flow data made it difficult to develop a historic record of I/I. As a result, there is not enough data to perform a reliable statistically analysis.

Figure 3.5 Average Monthly Flow at the Pease Wastewater Treatment Facility

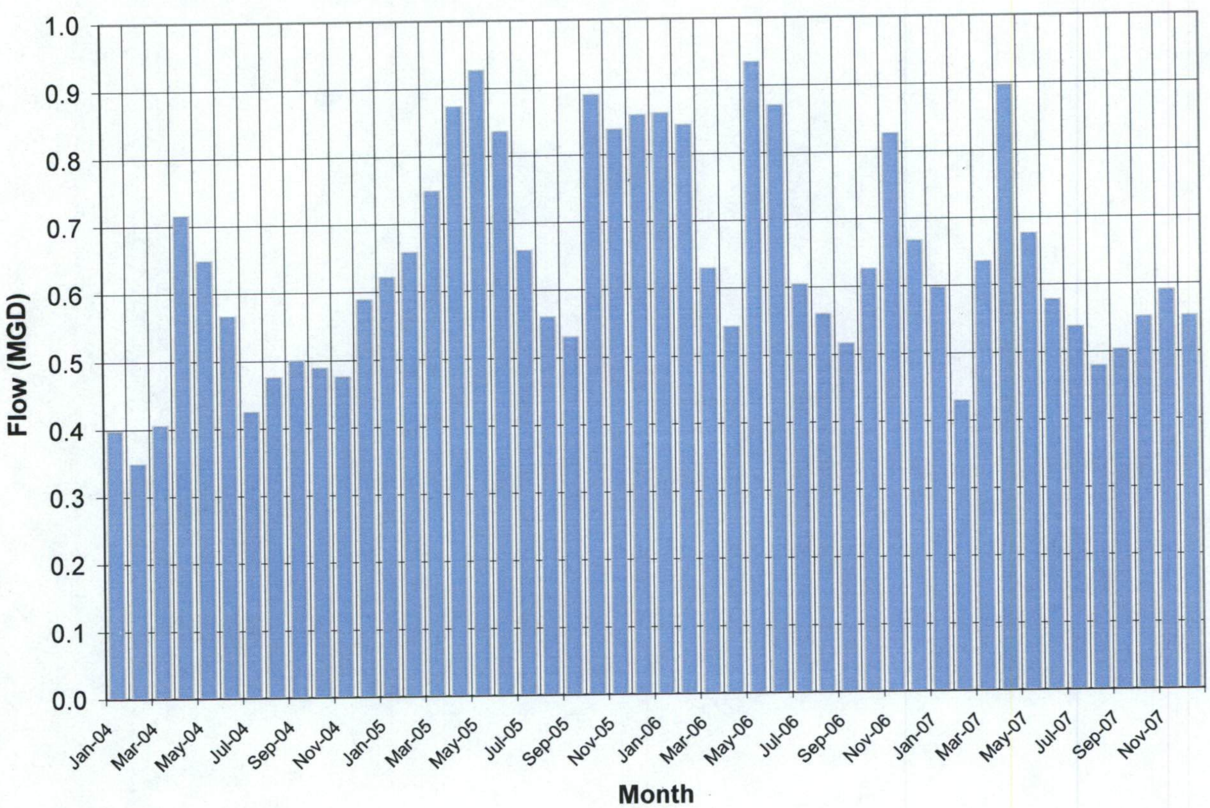
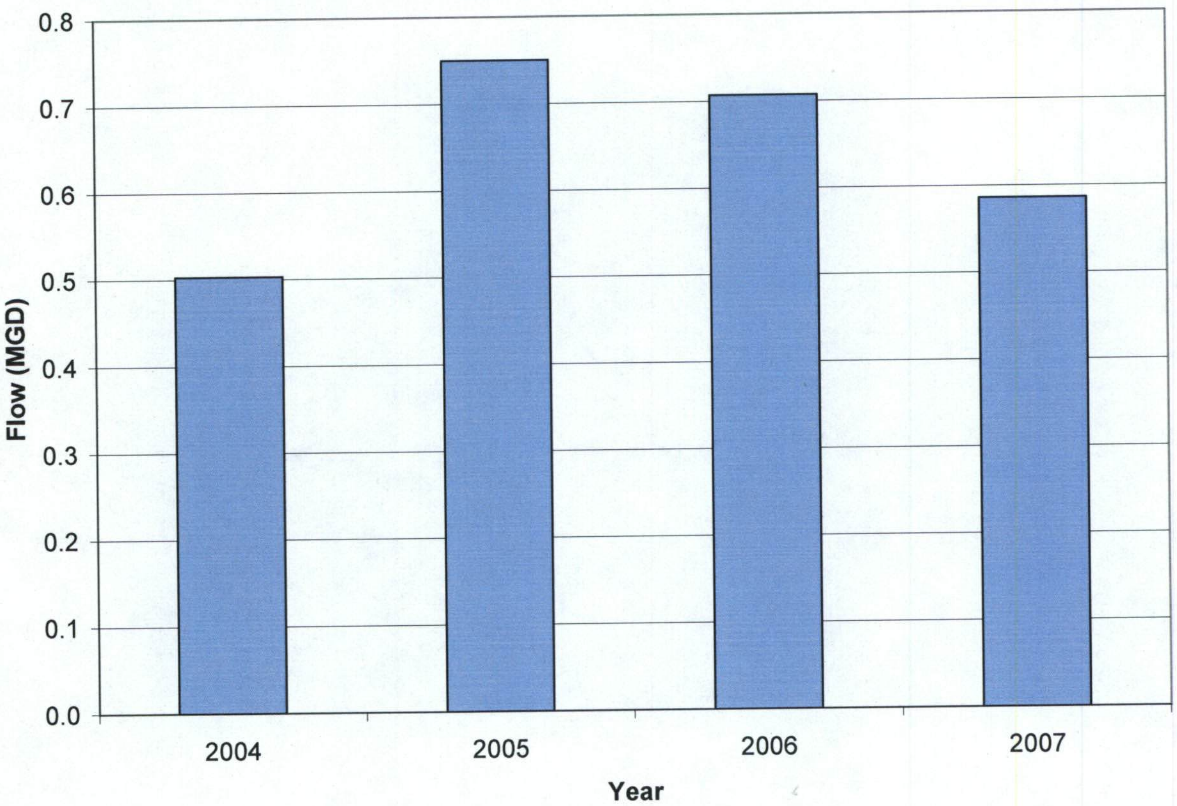


Figure 3.6 Average Annual Flow at the Pease Wastewater Treatment Facility



3.2.1.2.Influent Loads

This section presents the historic BOD and TSS influent loadings to the WWTFs.

Peirce Island Wastewater Treatment Facility

Historic influent BOD and TSS records were collected from Monthly Discharge Reports at the Peirce Island WWTF. The average annual influent loadings are shown in Figure 3.7 and Table 3.4. While there is variation from year to year, there does not seem to be a trend of either increasing or decreasing loads.

Figure 3.7 Average Annual Influent Loading Rate at the Peirce Island Wastewater Treatment Facility

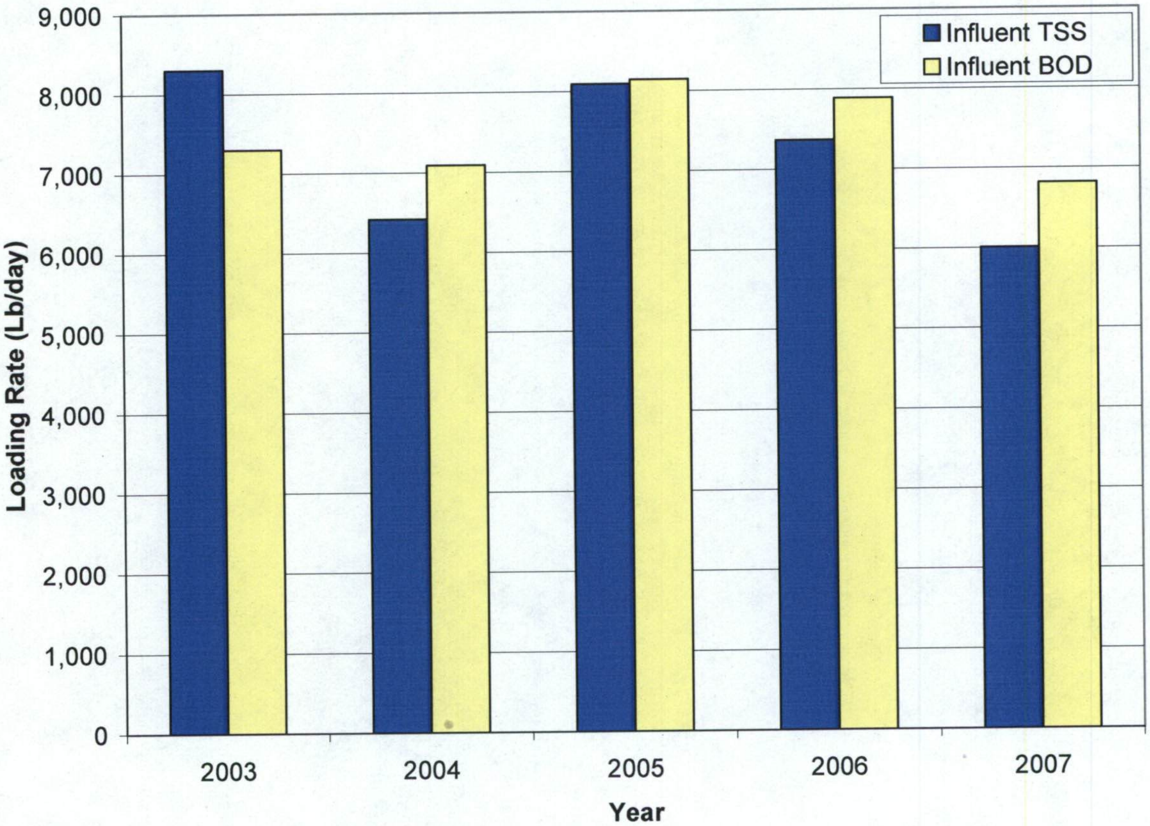


Table 3.4 Average Annual Influent Loading Rates at the Peirce Island Wastewater Treatment Facility

Year	Load (Lb/d)	
	BOD	TSS
2003	7,295	8,304
2004	7,090	6,416
2005	8,144	8,090
2006	7,887	7,368
2007	6,812	6,004

The estimated contribution of influent loadings to the Peirce Island WWTF by Portsmouth, Rye, Greenland, and New Castle are shown in Table 3.5. The influent loadings were distributed proportionally to the different sources based flow. As shown in the Table, Portsmouth is the overwhelming contributor of TSS and BOD to the Peirce Island WWTF.

Table 3.5 Average Annual Influent Loading Rates at the Peirce Island Wastewater Treatment Facility by Source

Source	Average Annual Loading Rate (lb/day)	
	BOD	TSS
Portsmouth	6,606 (1)	5,822 (1)
Rye	18 (1)	16 (1)
Greenland	24 (1)	21 (1)
New Castle	164 (1)	144 (1)
Total	6,812 (2)	6,004 (2)

Notes:

1. Estimated by multiplying total load at the WWTF by the percentage of sanitary flow contributed by the entity.
2. Total loads to the Peirce Island WWTF. Values developed from data measured from 1994 - 2007. Does not include loads discharged from the permitted CSOs.

The discharge of nitrogen is not regulated at the Peirce Island WWTF. However, the City has intermittently sampled influent nitrogen levels in 2008, collecting data to develop a baseline for future considerations, since nitrogen may be regulated in a future NPDES permit. Influent nitrogen data has been collected by grab sample at the Peirce Island with total nitrogen values ranging from 5 mg/l to 54 mg/l. Due to the limited number of samples that have been collected, sufficient data is not available to perform a statistically significant analysis.

Given the limited industry tributary to the Peirce Island WWTF, and based on data collected to date, the maximum total nitrogen of 54 mg/l at a flow of 6.7 mgd, which occurred on January 15, 2008 will be utilized. This equates to a mass load of approximately 3,000 lbs/d of total nitrogen. Future total nitrogen loads will be based on the incremental increase in mass associated with flow projections, as presented in Table 3.6.

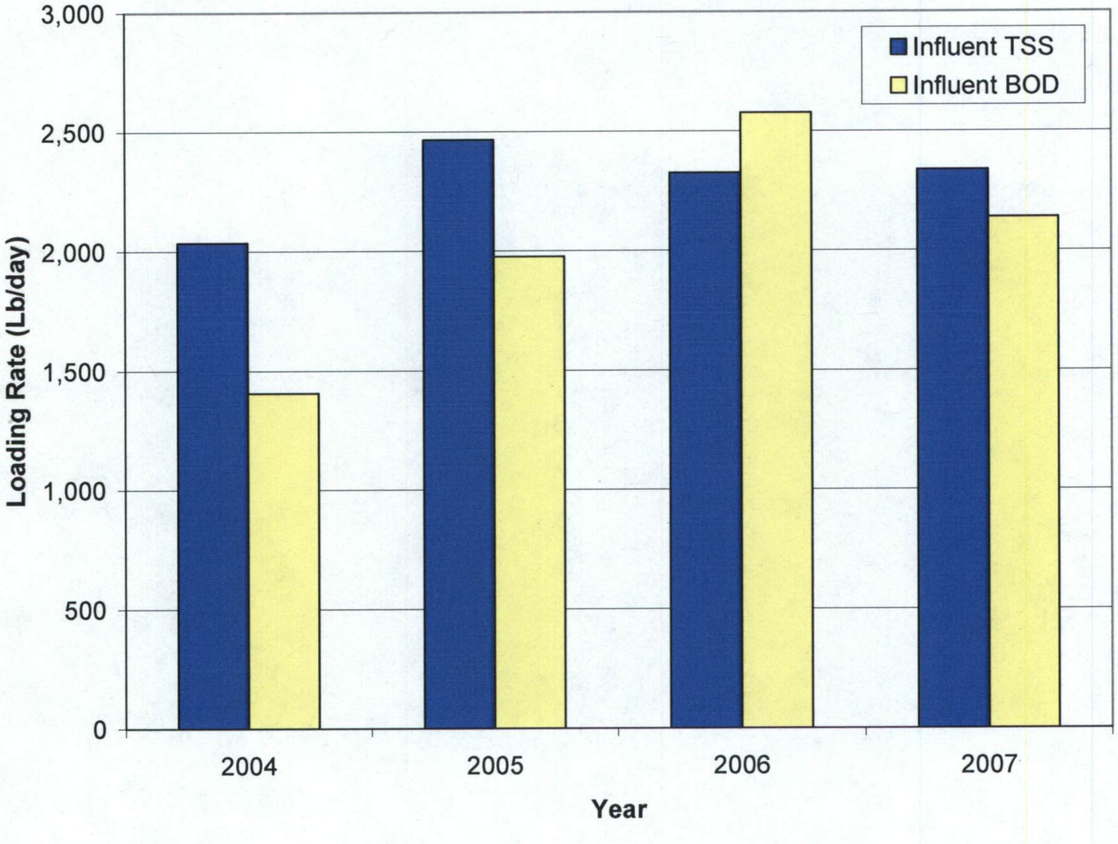
Table 3.6 Peirce Island WWTF Total Nitrogen Mass Loading

Year	Total Nitrogen (lbs/d)
2010	3,230
2020	3,510
2030	3,775
2040	3,950
2050	4,080
2060	4,090

Pease Wastewater Treatment Facility

Historic influent BOD and TSS records were collected from Monthly Discharge Reports at the Pease WWTF. The average annual influent loadings are shown in Figure 3.8 and Table 3.7. As mentioned previously, changes in industrial customer base have taken place since 2004. Figure 3.8 suggests that these changes have may have resulted in an increase in loadings, particularly BOD.

Figure 3.8 Average Annual Influent Loading Rate at the Pease Wastewater Treatment Facility



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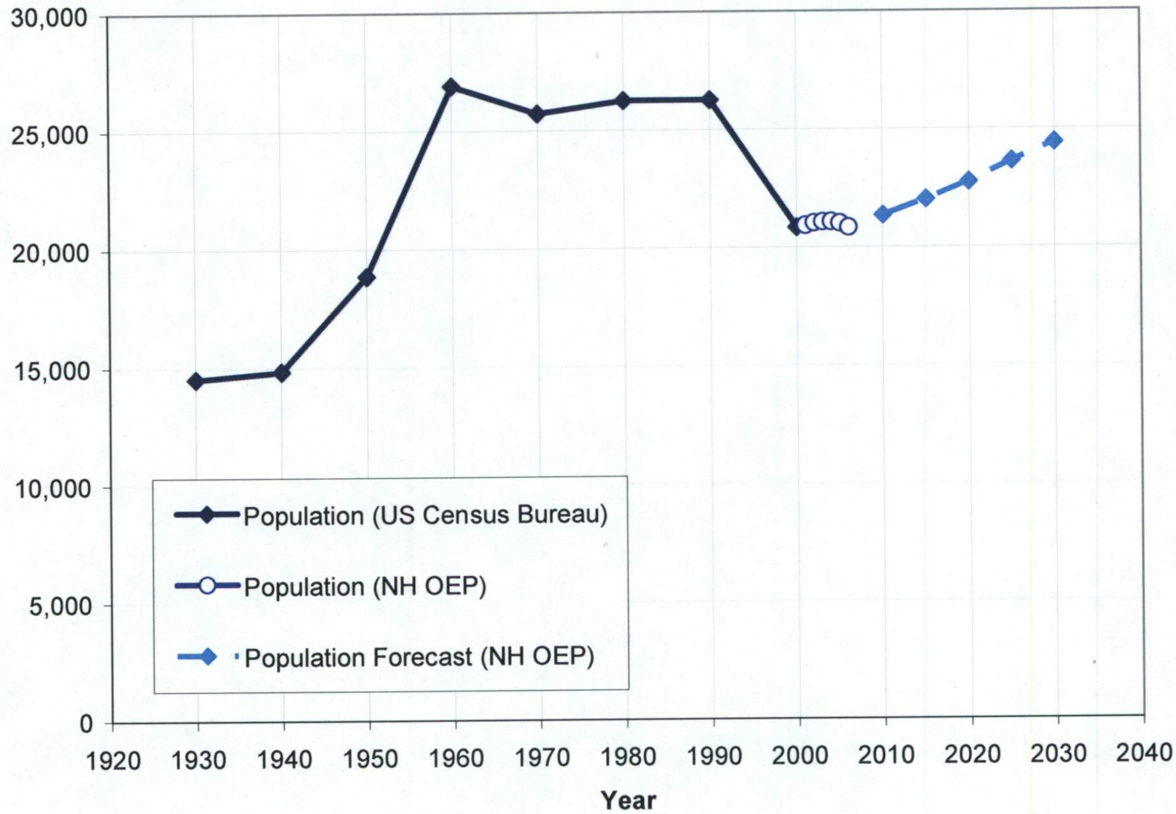
3.3. Population and Employment Forecasts

Population and employment forecasts provide the basis for developing the wastewater flow and load forecasts. Population forecasts were provided by the New Hampshire Office of Energy and Planning (NH OEP). The forecasts extend to the year 2030. The forecasts are shown in Figure 3.9 along with historic population data. The population peaked at 26,900 in 1960 and remained above a level of 25,000 people until the 1990s. The decline in the 1990s is due to the closing of the Pease Air Force Base. The population data from the NH OEP indicates that the population has remained fairly steady since 2000.

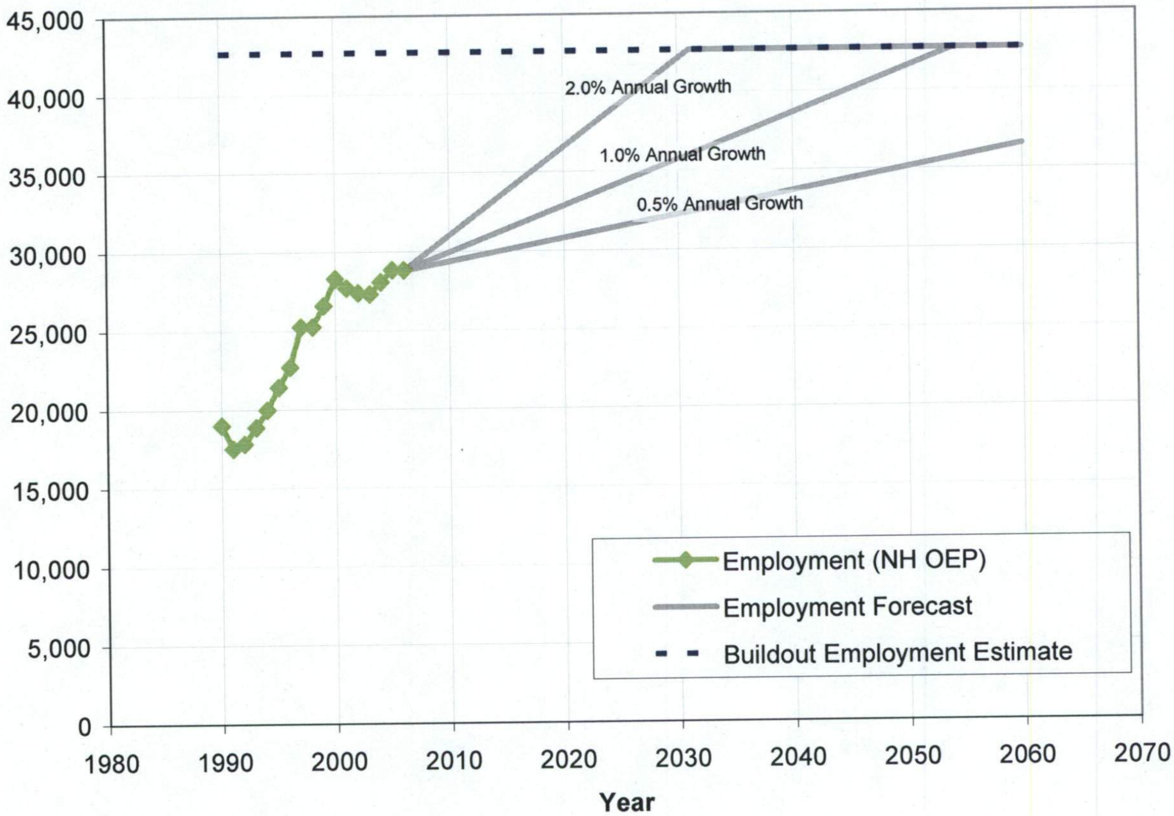
Figure 3.9 City of Portsmouth Historical and Forecasted Population



Employment forecasts for the City of Portsmouth were not available from NH OEP or any other planning agencies. There is a significant potential for growth in employment in Portsmouth (see Section 1.5). As a result, the employment forecast could have a strong impact on the wastewater flow and load forecasts.

With no forecasts available from planning agencies, low, medium, and high employment growth forecasts were developed. Under the low growth scenario, employment grows at 0.5 percent annually. The employment grows at 1.0 percent and 2.0 percent annually under the medium and high growth scenarios, respectively. The forecasts along with historic employment data are shown in Figure 3.10.

Figure 3.10 City of Portsmouth Historical and Forecasted Employment



The population and employment in the years 2000, 2006 and in the forecast years is shown in Table 3.8.

Table 3.8 City of Portsmouth Historic and Forecasted Population and Employment

Demographic	Year 2000		2006		2010		2020		2030		2040		2050		2060	
Population	20,825	(1)	20,811	(2)	21,320	(2)	22,730	(2)	24,390	(2)	25,881	(3)	27,373	(3)	27,450	(3)
Employment	28,258	(2)	28,768	(2)	29,343	(4)	30,782	(4)	32,220	(4)	33,659	(4)	35,097	(4)	36,535	(4)
					29,919	(5)	32,796	(5)	35,672	(5)	38,549	(5)	41,426	(5)	44,239	(5)
					31,069	(6)	36,823	(6)	42,577	(6)	42,653	(6)	44,239	(6)	44,239	(6)

Notes:

1. Source: United States Census Bureau
2. Source: New Hampshire Office of Energy and Planning
3. Assumes the average growth rate of the New Hampshire Office of Energy and Planning forecasts continues beyond 2030 until reaching the buildout population of 27,450 (see Section 3.5) in the year 2051.
4. Low growth employment forecast: 0.5% annual growth rate.
5. Medium growth employment forecast: 1.0% annual growth rate. Employment reaches buildout level of 44,239 in the year 2054.
6. High growth employment forecast: 2.0% annual growth rate. Employment reaches buildout level of 44,239 in the year 2031.

3.3.1. Buildout Population and Employment Forecasts

The buildout analysis estimated the maximum allowable density of development in the City. As noted earlier, the Capacity Assurance Planning Environment (CAPE) model was used to perform the analysis.

3.3.1.1. Undevelopable/Developable Area

The buildout analysis assumes that there are portions of the City in which future growth is restricted. For convenience, these areas are referred to as undevelopable areas even though there may already be some existing development. The undevelopable areas are defined as follows:

- Areas within 100 feet of freshwater bodies
- Areas within 50 feet of high tide mark north of Little Harbor
- Areas within 100 feet of high tide mark south of Little Harbor
- Conservation lands
- Cemeteries

The undevelopable area within the City of Portsmouth is shown in Figure 3.11.

3.3.1.2. Buildout Population

For areas zoned residential, the buildout population is estimated by performing the following steps for each parcel:

1. Determine the maximum number of lots that a parcel can be subdivided into
2. Multiply the number of lots by the number of people per household at buildout

The maximum number of lots that a parcel can be subdivided into is determined by the parcel's developable area and the minimum lot size required by zoning regulations. Table 3.9 shows the minimum lot size for each of the residential zoning districts.

Table 3.9 Minimum Lot Size for Residential Zoning Districts

Zoning	Description	Minimum Lot Size (square feet)
SRA	Single Residence A	43,560
SRB	Single Residence B	15,000
GRA	General Residence A	7,500
GRB	General Residence B	5,000
GA/MH	Garden Apartment/Mobile Home	10,000
A	Apartment	3,500
R	Rural Residential	217,800
MRO	Mixed Residential Office	7,500
MRB	Mixed Residential Business	7,500

Source: City of Portsmouth Zoning Ordinance (December 1995)

It was assumed that the number of people per household at buildout is 2.4 across all of the zoning districts. This value is considered conservative as it is higher than the average household size of 2.04 people per household in the year 2000.

In cases where the existing population in a parcel is greater than the calculated buildout population, the buildout population was reset to the existing population.

The estimated buildout population is 27,450[3]. If population growth proceeds at the rate consistent with the NH OEP forecasts, the buildout population will be reached in 2051.

The estimated buildout population by zoning district is shown in Table 3.10. With a limitation of areas for available residential growth and the desirability of living in the downtown area, it is assumed that residential development of areas zoned CBA and CBB will be allowed in the future.

Table 3.10 Estimated Buildout Population by Residential Zoning District

Zoning District	Description	Area (acres)	Developable Area (acres)	Buildout Population
A	Apartment	38	37	1,687
GA/MH	Garden Apartment/Mobile Home	250	106	1,601
CBA	Central Business District A	19	9	587
CBB	Central Business District B	55	52	3,216
GRA	General Residence A	267	240	4,995
GRB	General Residence B	70	58	2,064
MRB	Mixed Residential Business	31	30	420
MRO	Mixed Residential Office	60	55	1,473
R	Rural Residential	604	105	122
SRA	Single Residence A	963	305	1,619
SRB	Single Residence B	1,366	883	9,668
	Total	3,723	1,881	27,450

3.3.1.3.Buildout Employment

For area zoned commercial/institutional/industrial, the buildout employment is estimated by performing the following steps for each parcel:

1. Calculate the amount of building floor space by multiplying the building floor area to parcel area (FAR) ratio by the developable area of the parcel
2. Multiply the amount of building floor space by the building floor area per employee (FER) ratio

[3] The estimated buildout population of the 201 Facilities Plan Update (Underwood Engineers, Inc., November 1999) was 26,330. The difference is likely due to changes in zoning and the assumption by this Study that residential development will be allowed in the CBA and CBB zoning districts.

Table 3.10 shows the FAR ratios for each of the commercial/ institutional/ industrial zoning districts. The maximum allowable FARs were determined from the City's Zoning Ordinance. Current FARs were calculated using available GIS data.

During the development of the employment buildout forecast, it was determined that using the maximum FARs allowable under the current zoning ordinance resulted in an estimated buildout employment in excess of 600,000. This estimate was clearly too high. In order to arrive at a more realistic estimate, a growth factor was applied to the existing FARs[4]. The growth factors were developed through discussions with City staff about where increased density of development is likely to occur. The FARs used in the buildout analysis are shown in Figure 3.11.

It was assumed that the FER will be 500 square feet per employee at buildout for all of the zoning districts.

Table 3.11 Floor to Parcel Area Ratios for Commercial/Industrial/Institutional Zoning

Zoning District	Description	Maximum FAR (1)	Current FAR (2)	Assumed FAR at Buildout (3)
ABC	Airport Business Commercial	4.8	0.08	0.13 (4)
AI	Airport Industrial	4	0.08	0.17 (4)
AIR	Airport	1	0	0.01 (4)
B	Business	1.8	0.32	0.40
CBA	Central Business A	3.5	0.5	0.75
CBB	Central Business B	5.7	1.28	1.50
GB	General Business	2.1	0.08	0.10
I	Industrial	3.5	0.06	0.08
M	Municipal	NA	0.04	NA
MRB	Mixed Residential Business	1.6	0.2	0.30
MRO	Mixed Residential Office	1.6	0.36	0.40
NRP	Natural Resource Protection	NA	0	NA
OR	Office Research	1.8	0.13	0.15
OR/MV	Office Research/Marine's Village	1.8	0.04	0.15
PI	Pease Industrial	2.4	0.12	0.17 (4)
WB	Waterfront Business	0.9	0.06	0.08
WI	Waterfront Industrial	3.5	0.1	0.15

Notes:

1. City of Portsmouth Zoning Ordinance (December 1995)
2. Values developed from GIS analysis using existing zoning boundaries, parcel areas, and building floor areas
3. Unless otherwise noted, values were estimated by applying a growth factor to FARs. The growth factor was estimated based on discussions with City staff about what areas are likely to experience high density development.
4. Developed from a buildout analysis performed by Underwood Engineers, Inc. of the Pease Development Authority.

[4] The assumed FARs at buildout for zoning districts in the Pease Development Authority were calculated differently. They were based on values developed by Underwood Engineers for a buildout analysis of the Pease Development Authority.

The estimated number of employees at buildout is 44,239. Employment by zoning district at buildout is shown in Table 3.12.

Currently, there is an estimated 1.4 employees per resident in Portsmouth. At buildout, this ratio is estimated to be 1.6 employees per resident. For comparison purposes, a survey of 164 communities under existing conditions in the greater Boston area found that only three communities had employee to resident ratios of 1.4 or greater. The communities included Bedford, Burlington, and Avon with ratios of 1.7, 1.6, and 1.4 employees per resident, respectively.

Table 3.12 Estimated Buildout Employment by Zoning District

Zoning District	Description	Area (acres)	Developable Area (acres)	Buildout Employment
ABC	Airport Business Commercial	654	474	6,386
AI	Airport Industrial	103	77	1,464
AIR	Airport	1,572	1,287	1,198
B	Business	59	56	2,402
CBA	Central Business A	19	9	635
CBB	Central Business B	55	52	4,805
GB	General Business	709	453	7,104
I	Industrial	840	400	5,428
M	Municipal	624	45	2,037
MRB	Mixed Residential Business	31	30	497
MRO	Mixed Residential Office	60	55	1,408
NRP	Natural Resource Protection	1,084	33	132
OR	Office Research	285	158	4,336
OR/MV	Office Research/Marine's Village	107	88	1,293
PI	Pease Industrial	183	121	2,680
WB	Waterfront Business	29	10	197
WI	Waterfront Industrial	180	107	2,238
Total		6,594	3,456	44,239

The year in which buildout employment would be reached for the three different employment growth scenarios is shown in Table 3.13.

Table 3.13 Estimate of Employment Buildout Year

Scenario	Growth Rate	Buildout Employment Year
Low	0.5%	2102
Medium	1.0%	2054
High	2.0%	2031

3.3.2. Sewered Area

The type of wastewater service currently employed in parcels throughout the City of Portsmouth is shown in Figure 3.12. The type of wastewater service was estimated by proximity to sewer. Parcels with no development were considered to have no wastewater service. Table 3.14 presents a summary of sewer service throughout the City. As can be seen from Figure 3.12 and Table 3.14, most of the City of Portsmouth is currently sewered.

Table 3.14 Wastewater Service in City of Portsmouth

Wastewater Service	Parcels		Area (acres)	
Sewered	5,794	(92%)	6,434	(63%)
On-Site	355	(6%)	748	(7%)
None	166	(3%)	2,969	(29%)
Total	6,315	(100%)	10,151	(100%)

3.3.3. Development of Wastewater Generation Rates

The development of wastewater flow and loading rates is discussed in this section. These rates will be used along with the demographic forecasts in Section 1.5 to develop wastewater flow and loading forecasts for the WMP.

3.3.3.1. Wastewater Flows for Current Conditions

The sections which follow discuss the calibration of the wastewater unit flow rates for the residential population and commercial/institutional/industrial development. Different types of commercial/institutional/industrial development produce different amounts of flow. For example, a retail shopping complex may produce less wastewater than an industrial factory per square foot of building floor space. Likewise, there is variability in flow generation rates in residential development. For example, per capita wastewater generation may be lower in apartments than single-family housing. In order to account for variability in wastewater generation rates for different development types, wastewater generation rates were developed for the different existing use types shown in Table 3.15.

Table 3.15 Existing Use Types

Residential Use	
1F	Single family
2F	Two family
3F	Three family
MF	Apartment
MH	Mobile Home
Commercial Use	
HOTEL	Inn/Hotel
STORE	Store
REST	Restaurant
AUTO	Automotive
WASH	Carwash
COM-OTH	Other
GYM	Gym
OFFICE	Office
Institutional Use	
HOSP	Hospital
SCH	School
CF	Care facility
MUNI	Municipal
INT-OTH	Other
Mixed Use	
MIXED	Mixed Use
Other Use	
UNDEV	Undeveloped
CEM	Cemetery
OUT	Outbuilding

Water Usage Records

Water use records were matched with their respective parcels and unit flow generation rates were calculated. Since outdoor water usage is at a minimum during the winter and spring, the analysis of water use records was performed from the period of time from January 2007 through May 2007.

Approximately 5,000 of the 8,000 water accounts and 43,000 out 70,000 water meter readings were matched with parcels in Portsmouth. A sizable portion of the unmatched accounts and water meter readings are for water usage outside of Portsmouth.

The average daily water usage for all of the water accounts from January 2007 through May 2007 was 2.78 MGD. The average daily water usage in the Portsmouth parcels that were matched with water accounts was 1.36 MGD, approximately half of the total.

Water Usage by Residential Development

Residential water usage in parcels with matched water accounts is shown in Table 3.16. The water usage in these parcels totaled 0.70 MGD. If the per capita flow rates in Table 3.16 are extrapolated to the rest of the sewered population in Portsmouth, the total water usage is estimated to be 0.88 MGD.

Table 3.16 Residential Water Usage in Parcels with Matched Water Accounts (January – Mary 2007)

Existing Use		Parcels with Matched Water Accounts			
Code	Description	Count	Population	Average Daily Water Usage (gpd)	Per capita flow rate (gpcd)
1F	Single family	3,472	11,123	432,946	39
2F	Two family	353	1,498	62,233	42
3F	Three family	74	404	19,061	47
MF	Apartment	144	2,552	126,324	49
MIXED	Mixed Use	304	1,480	61,558	42

The water usage rates range as shown in Table 3.14 vary from 39 to 49 gallons per capita per day. Typical municipal water use varies from 40-130 daily per capita consumption (gpcd) in the United States with an average rate of 60 gpcd (Metcalf and Eddy, 1991).

Water Usage by Commercial/Institutional/Industrial Development

Commercial/institutional/industrial water use in parcels with matched water accounts is shown in Table 3.17. The water use in these parcels totaled 0.66 MGD. If the per building area flow rates in Table 3.17 are extrapolated to the rest of the sewered commercial/industrial/institutional development in Portsmouth, the total water usage is estimated to be 0.93 MGD.

Table 3.17 Commercial/Industrial/Institutional Water Usage in Parcels with Matched Water Accounts (January – Mary 2007)

Existing Use		Parcels with Matched Water Accounts			
Code	Description	Count	Building Floor Area (sq ft)	Average Daily Water Usage (gpd)	Per Building Area Flow Rate (gpsfd)
HOTEL	Inn/Hotel	14	969,936	21,656	0.022
STORE	Store	77	2,229,187	62,477	0.028
REST	Restaurant	31	275,872	30,648	0.111
AUTO	Automotive	47	556,797	18,451	0.033
WASH	Carwash	3	10,266	14,148	1.378
COM-OTH	Other	4	72,999	1,028	0.014
GYM	Gym	1	32,985	192	0.006
OFFICE	Office	109	2,556,223	49,729	0.019
HOSP	Hospital	1	755,490	21,639	0.029
SCH	School	7	657,441	1,573	0.002
CF	Care facility	3	76,935	16,996	0.221
MUNI	Municipal	18	956,187	4,655	0.005
INT-OTH	Other	53	698,234	14,963	0.021
MIXED	Mixed Use	304	1,803,427	153,895	0.085
IND-GEN	General industrial	77	5,175,622	302,742	0.058
UNDEV	Undeveloped	5	225,050	1,958	0.009
CEM	Cemetery	0	NA	NA	NA
OUT	Outbuilding	3	66,344	462	0.007

3.3.3.2.Sanitary Flow

As shown in Table 3.3, the City of Portsmouth contributes 2.53 MGD of sanitary flow to the Peirce Island WWTF and 0.41 MGD of sanitary flow to the Pease WWTF. However, the total estimated water usage in the sewered portions of the City is only 1.81 MGD (0.88 MGD for residential areas and 0.93 MGD from commercial/institutional/industrial areas). The reason for discrepancy is unknown. However, the low per capita wastewater generation rates support the conclusion that water usage is being under measured.

The sanitary flow generation rates for each of the existing uses were calibrated until they matched the expected flow rates at the WWTFs attributable to the City. The resulting wastewater generation rates for the existing use types are shown in Tables 3.18 and 3.19 for the residential and commercial/industrial/institutional existing uses, respectively. The wastewater generation rates seem to be within a reasonable range.

Table 3.18 Calibrated Wastewater Generation Rates for Residential Existing Uses

Existing Use		Per capita flow rate (gpcd)
Code	Description	
1F	Single family	72
2F	Two family	68
3F	Three family	68
MF	Apartment	65
MH	Mobile Home	65
MIXED	Mixed Use	68

Table 3.19 Calibrated Wastewater Generation Rates for Existing Commercial/Industrial/Institutional Uses

Existing Use		Per building area flow rate (gpsfd)
Code	Description	
HOTEL	Inn/Hotel	0.07
STORE	Store	0.06
REST	Restaurant	0.24
AUTO	Automotive	0.08
WASH	Carwash	2.62
COM-OTH	Other	0.03
GYM	Gym	0.04
OFFICE	Office	0.05
HOSP	Hospital	0.05
SCH	School	0.02
CF	Care facility	0.42
MUNI	Municipal	0.02
INT-OTH	Other	0.05
MIXED	Mixed Use	0.20
IND-GEN	General industrial	0.15
UNDEV	Undeveloped	0.00
CEM	Cemetery	0.00
OUT	Outbuilding	0.04

3.3.3.3. I/I

In accordance with Phase I of its 2005 Long Term Control Plan, the City of Portsmouth has on ongoing program to separate targeted combined sewers. When completed, it is expected that this program will reduce the amount of extraneous flows entering the City's collection system, reduce CSO activity, and some level of I/I. However, it is also recognized that the system will continue to age and deteriorate with time, and that this will lead to more I/I entering the system. As a result, it is assumed that these two effects will balance the other so that rates of I/I could actually remain relatively unchanged during the planning horizon.

3.3.4. Wastewater Unit Flow Rates for Future Conditions

The CAPE model transitions development in the parcels from the existing land use type to the zoning land over a period of 20 years. The wastewater unit flow rates for the existing types were discussed in the previous section. This section presents the wastewater unit flow rates for the zoned land use types.

The wastewater unit flow rates for the zoning districts were based on an analysis of the wastewater unit flow rates for existing uses. The wastewater unit flow rates for residential zoning districts are shown in Table 3.20. The wastewater unit flow rates for commercial/industrial/institutional zoning districts are shown in Table 3.21.

Table 3.20 Residential Wastewater Generation Rates for Zoning Districts

Zoning District		Loading Rate (gpcd)
Code	Description	
A	Apartment	70
GA/MH	Garden Apartment/Mobile Home	70
GRA	General Residence A	75
GRB	General Residence B	75
MRB	Mixed Residential Business	70
MRO	Mixed Residential Office	70
R	Rural Residential	85
SRA	Single Residence A	85
SRB	Single Residence B	85

Source: Values were estimated based on an analysis of wastewater generation rates for similar existing uses (see Table 3.18)

Table 3.21 Commercial/Industrial/Institutional Wastewater Generation Rates for Zoning Districts

Zoning District		Loading Rate (gpsfd)
Code	Description	
ABC	Airport Business Commercial	0.05
AI	Airport Industrial	0.08
AIR	Airport	0.05
B	Business	0.05
CBA	Central Business A	0.15
CBB	Central Business B	0.15
GB	General Business	0.05
I	Industrial	0.15
M	Municipal	0.01
MRB	Mixed Residential Business	0.2
MRO	Mixed Residential Office	0.2
NRP	Natural Resource Protection	0.02
OR	Office Research	0.05
OR/MV	Office Research/Marine's Village	0.04
PI	Pease Industrial	0.1
WB	Waterfront Business	0.1
WI	Waterfront Industrial	0.05

Source: Values were estimated based on an analysis of wastewater generation rates for similar existing uses (see Table 3.19)

3.3.5. Unit Loading Rates

Historical BOD and TSS loadings were discussed in Section 1.3. BOD and TSS loadings have remained fairly level at the Peirce Island WWTF. It is assumed that the average of BOD and TSS loadings from 2003 through 2007 represent average conditions. Loading rates at Pease have varied in the recent past due to changes in industries within the Pease Development Authority. It is assumed, however, that the last two years reflect average conditions. The assumed average annual loadings at the two WWTFs under current conditions are shown in Table 3.22.

Table 3.22 Estimated Average Annual Loadings for Current Conditions

	BOD (lb/day)	TSS (lb/day)
Peirce Island WWTF		
Portsmouth	7,220	7,018
Others	225	219
Total	7,446	7,236
Pease WWTF	2,357	2,331

BOD and TSS unit loading rates were developed. BOD and TSS loading rates were assumed to be 0.2 pound per capita per day (lbpcd) for the residential population. These rates are typical values (Metcalf and Eddy, 1991). The BOD and TSS loading rates for commercial/institutional/industrial development were then calibrated to achieve the target system-wide values. Different loading rates were developed for commercial/institutional/ industrial development tributary to the WWTFs. The BOD and TSS loading rates for commercial/institutional/industrial development were expressed in pounds per square feet of building floor space per day (lbsfd). The results are shown in Table 3.23.

Table 3.23 BOD and TSS Unit Loading Rates

Contributor	BOD	TSS
Residential Population	0.20 lbpcd	0.20 lbpcd
Commercial/Institutional/Industrial Development		
Tributary to Peirce Island WWTF	0.0003 lbsfd	0.0002 lbsfd
Tributary to Pease WWTF	0.0006 lbsfd	0.0006 lbsfd

It is assumed that the loading rates shown in Table 3.23 will also apply to future growth in the study area.

3.3.6. Wastewater Flow and Load Forecasts

The information developed in the previous Sections was used to develop wastewater flow and load forecasts for the Peirce Island and Pease WWTFs. In developing the forecasts, it was assumed that the entire City of Portsmouth will be sewered between the years 2010 and 2020 (see Section 1.5 for a discussion of current sewering conditions).

The forecasted sanitary flows for the Peirce Island WWTF are shown in Table 3.24. Flows from each of the contributing communities are shown. The Portsmouth flows are presented for the three different employment growth scenarios (each of these scenarios also includes the NH OEP forecasted population). The difference in the sanitary flows in the year 2060 at the Peirce Island WWTP between the low and high employment growth scenarios is approximately 200,000 gpd.

The flow forecasts for New Castle and Rye are based on the assumption of full utilization of the flow entitlements by the year 2030. The flow forecasts for Greenland are based on full utilization of available sewer service capacity by the year 2030.

Table 3.24 Forecasted Sanitary Flows for the Peirce Island WWTF

Source	Sanitary Flow (gpd)					
	2010	2020	2030	2040	2050	2060
Portsmouth						
Low employment growth (0.5%)	2,552,171	2,853,152	3,034,826	3,153,561	3,272,295	3,298,614
Medium employment growth (1.0%)	2,560,366	2,896,858	3,112,151	3,264,506	3,416,860	3,476,799
High employment growth (2.0%)	2,571,179	2,961,559	3,226,624	3,369,085	3,471,769	3,482,037
Other Communities						
Greenland (1)	16,783	37,267	62,000	62,000	62,000	62,000
New Castle (2)	82,174	126,492	180,000	180,000	180,000	180,000
Rye (3)	24,783	82,391	140,000	140,000	140,000	140,000
Total						
Low employment growth (0.5%)	2,675,910	3,099,303	3,416,826	3,535,561	3,654,295	3,680,614
Medium employment growth (1.0%)	2,684,106	3,143,008	3,494,151	3,646,506	3,798,860	3,858,799
High employment growth (2.0%)	2,694,918	3,207,710	3,608,624	3,751,085	3,853,769	3,864,037

Notes:

1. Existing pump station capacity.
2. Report prepared by CMA Engineers.
3. Intermunicipal Agreement

The total forecasted wastewater flows for the Peirce Island WWTF are presented in Table 3.25. The flows shown in the table include sanitary flow and I/I. As mentioned in Section 3.7.1.5, the I/I is assumed to remain at the levels presented in Table 3.3 through the planning horizon.

Table 3.25 Forecasted Wastewater Flows for the Peirce Island WWTF

Condition	Total Wastewater Flow (MGD)					
	2010	2020	2030	2040	2050	2060
Average Annual						
Low employment growth (0.5%)	5.07	5.49	5.81	5.93	6.04	6.07
Medium employment growth (1.0%)	5.07	5.53	5.88	6.04	6.19	6.25
High employment growth (2.0%)	5.08	5.60	6.00	6.14	6.24	6.25
10-Year Maximum Average Annual						
Low employment growth (0.5%)	5.80	6.22	6.54	6.66	6.77	6.80
Medium employment growth (1.0%)	5.80	6.26	6.61	6.77	6.92	6.98
High employment growth (2.0%)	5.81	6.33	6.73	6.87	6.97	6.98
10-Year Maximum Month						
Low employment growth (0.5%)	8.83	9.25	9.57	9.69	9.80	9.83
Medium employment growth (1.0%)	8.83	9.29	9.64	9.80	9.95	10.01
High employment growth (2.0%)	8.84	9.36	9.76	9.90	10.00	10.01

The forecasted sanitary flows for the Pease WWTF are shown in Table 3.26. The wastewater forecasts for different I/I scenarios are presented in Table 3.27.

Table 3.26 Forecasted Sanitary Flows for the Pease WWTF

Employment Scenario	Sanitary Flow (gpd)					
	2010	2020	2030	2040	2050	2060
Low growth (0.5%)	447,943	581,306	714,208	847,288	980,368	1,114,599
Medium growth (1.0%)	470,198	677,744	884,830	1,092,093	1,299,357	1,507,771
High growth (2.0%)	531,739	944,374	1,356,559	1,520,737	1,519,458	1,519,331

Table 3.27 Forecasted Wastewater Flows for the Pease WWTF

Condition	Total Wastewater Flow (MGD)					
	2010	2020	2030	2040	2050	2060
Average Annual						
Low employment growth (0.5%)	0.68	0.81	0.94	1.08	1.21	1.34
Medium employment growth (1.0%)	0.70	0.91	1.11	1.32	1.53	1.74
High employment growth (2.0%)	0.76	1.17	1.59	1.75	1.75	1.75
10-Year Maximum Average Annual						
Low employment growth (0.5%)	0.79	0.92	1.05	1.19	1.32	1.45
Medium employment growth (1.0%)	0.81	1.02	1.22	1.43	1.64	1.85
High employment growth (2.0%)	0.87	1.28	1.70	1.86	1.86	1.86
10-Year Maximum Month						
Low employment growth (0.5%)	0.98	1.11	1.24	1.38	1.51	1.64
Medium employment growth (1.0%)	1.00	1.21	1.41	1.62	1.83	2.04
High employment growth (2.0%)	1.06	1.47	1.89	2.05	2.05	2.05

The influent BOD forecasts for the Peirce Island the Pease WWTFs are presented in Table 3.28 for the three different employment growth scenarios. The influent TSS forecasts for the two WWTFs are presented in Table 3.29.

Table 3.28 Forecasted BOD for the Peirce Island and Pease WWTFs

	Influent BOD (lb/d)					
	2010	2020	2030	2040	2050	2060
Low Employment Growth						
Peirce Island WWTF	7,266	7,659	8,027	8,355	8,682	8,747
Pease WWTF	2,340	2,488	2,634	2,781	2,928	3,074
Total	9,607	10,147	10,661	11,136	11,610	11,821
Medium Employment Growth						
Peirce Island WWTF	7,266	7,758	8,223	8,647	9,072	9,234
Pease WWTF	2,340	2,675	3,009	3,343	3,676	4,010
Total	9,607	10,433	11,232	11,990	12,748	13,244
High Employment Growth						
Peirce Island WWTF	7,335	7,971	8,572	8,971	9,263	9,292
Pease WWTF	2,549	3,246	3,942	4,220	4,220	4,220
Total	9,884	11,217	12,514	13,192	13,483	13,512

Table 3.29 Forecasted TSS for the Peirce Island and Pease WWTFs

	Influent TSS (lb/d)					
	2010	2020	2030	2040	2050	2060
Low Employment Growth						
Peirce Island WWTF	7,064	7,449	7,815	8,140	8,465	8,528
Pease WWTF	2,314	2,460	2,605	2,750	2,895	3,040
Total	9,378	9,909	10,420	10,890	11,360	11,568
Medium Employment Growth						
Peirce Island WWTF	7,064	7,542	7,998	8,413	8,828	8,981
Pease WWTF	2,314	2,645	2,975	3,305	3,635	3,965
Total	9,378	10,187	10,973	11,718	12,464	12,947
High Employment Growth						
Peirce Island WWTF	7,128	7,740	8,323	8,715	9,006	9,035
Pease WWTF	2,521	3,210	3,898	4,173	4,173	4,173
Total	9,649	10,950	12,221	12,888	13,180	13,209

3.4. Sludge and Biosolids Forecasting

WWTFs produce various organic and chemical wastes that must be disposed of. Organic sludges are produced in primary clarifiers, at WWTFs so equipped. The sludges can be both organic and chemical in nature, if the WWTF utilized chemically enhanced primary treatment (CEPT), as employed at the Peirce Island WWTF. In general the chemical is usually a metal salt utilized enhance coagulation.

Biosolids are an organic byproduct of secondary treatment, and the rate of production is dependent on the treatment process employed. Lagoons have a very low biosolids yield, while high rate treatment processes have a relatively high yield. In general, lagoon systems do not waste sludge, and instead allow it to build in the settling lagoon. Activated sludge facilities usually waste biosolids on a daily basis.

Facilities which utilize tertiary treatment may also produce chemical sludges containing metal salts. Currently, only the Somersworth, NH WWTF utilizes tertiary treatment. However, it is likely that many of the WWTFs in the area may be producing tertiary sludges in the future, as discharge permit limits become more stringent.

3.4.1. Current Conditions

In addition to the Peirce Island and Pease WWTFs, there are 14 other WWTFs in the Study Area which, if a regional sludge and biosolids handing facility were constructed, might utilize it for disposal. In addition, four (4) local Maine communities might also utilize a regional facility, if it were available. Therefore, a total of 18 additional WWTFs may utilize a regional facility for sludge / biosolids disposal, if it were available.

Of the additional WWTFs included in this analysis, five (5) are either current or former lagoon systems. The sludge/biosolids production from these facilities are stored in lagoons, and these facilities were not been considered in this analysis. Typically, lagoon storage systems are desludged every 10 to 15 years, and while a regional facility may be identified as a disposal option, the impact would be short term. Therefore, sizing of the regional facility would not be based on the capacity required for the lagoon systems.

The breakdown of WWTFs which may contribute sludge and/or biosolids to a regional handling facility and its current production is summarized in Table 3.30.

All of the facilities listed dewater the sludge/biosolids prior to disposal, with dewatered sludge solids content ranging from a low of 12% solids to a high of 30% solids. The wet ton quantity includes both the sludge/biosolids residual liquid, as well as the actual solids. The dry ton quantity includes only the actual weight of the solids.

Table 3.30 Current WWTF Annual Sludge/Biosolids Production

Wastewater Facility	Sludge/Biosolids Produced (Wet Tons)		Sludge/Biosolids Produced (Dry Tons)	
	2006	2007	2006	2007
Dover, NH	3,450	3,450	690	690
Durham, NH	1,800	1,860	400	420
Epping, NH (a)	0	0	0	0
Exeter, NH (a)	0	0	0	0
Farmington, NH	1,800	1,800	350	350
Hampton, NH	3,200	2,700	740	620
Newfields, NH	0	0	0	0
Newington, NH	440	250	55	50
Newmarket, NH	130	160	20	30
Rochester, NH (a)	0	0	0	0
Rockingham Cnty, NH (a)	0	0	0	0
Rollinsford, NH (b)	0	0	0	0
Seabrook, NH	1,500	1,415	225	210
Somersworth, NH (c)	2,200	2,400	440	480
Berwick, ME	1,945	1,810	485	450
Kittery, ME	720	800	180	200
South Berwick, ME	2,600	2,600	600	600
York, ME	1,340	1,480	160	180
Pease WWTF	890	860	160	155
Peirce Island WWTF (d)	2,515	2,815	755	845
TOTALS:	**24,530**	**24,400**	**5,260**	**5,280**

a. Biosolids retained in lagoon system
b. Included in South Berwick, ME data
c. Estimated, data currently unavailable
d. Includes chemical sludge from CEPT system

3.4.2. Future Conditions

As presented herein, growth through the year 2030 must be considered to provide for a sustainable system. Project flows and loads for the City's WWTFs as well as specific WWTFs in the surrounding area have been developed. However, sludge and biosolids production is not only driven by an increase in flow or organic load. More stringent permit conditions will also increase WWTF sludge and biosolids production. For example, if a WWTF is required to reduce effluent nutrients, then biosolids production associated with the biological nutrient removal (BNR) processes will increase. Also, if a WWTF is required to utilize chemical precipitates to reduce pollutants, such as phosphorus, this will also increase sludge production.

3.4.2.1.Peirce Island WWTF

The largest increase in biosolids production will be associated with the Peirce Island WWTF, which will be converted from a primary to a secondary WWTF. In addition, it is assumed the WWTF will meet a future total nitrogen permit limit.

Sludge and biosolids generation projections at the Peirce Island WWTF have been developed based on the following:

- The highest TSS/BOD forecasts are utilized,
- Evaluations have been performed for the following two scenarios:
  - CEPT will either remain at the Peirce Island WWTF when converted to secondary treatment or will be applied to a new replacement secondary WWTF. Influent BOD will be reduced by 55% and TSS by 77% in the primary clarifiers.
  - CEPT will not be utilized, and influent BOD will be reduced by 30% and TSS by 50% in the primary clarifiers.
- Secondary biosolids will be generated at a rate of 1.5 lbs per pound of BOD applied to the secondary process, assuming that a high rate biological nutrient reduction (BNR) process is utilized..
- No reduction in volatile solids will occur.

In addition to sludge and biosolids loading, nitrogen loading associated with dewatered sludge has also been considered. Data specific to the Peirce Island WWTF for actual nitrogen levels in the dewatering filtrate is not available; therefore, text book values of 150 mg/l have been used for this evaluation.

Assuming that CEPT remains in use, biosolids and sludge yield will increase, as presented in Table 3.31. Should CEPT be discontinued, sludge and biosolids yield will increase as presented in Table 3.32. Should sludge be further dried from 30% solids to 90% solids, the total nitrogen load associated with the condensate will increase by approximately 5%.

Table 3.31 Sludge/Biosolids Production with CEPT

		Year						
		2007	2010	2020	2030	2040	2050	2060
BOD Load (wet)	(lbs/day)	6,812	7,335	7,971	8,572	8,971	9,263	9,292
TSS Load (wet)	(lbs/day)	6,004	7,128	7,740	8,323	8,715	9,006	9,035
Primary Sludge Generation [(a)]	(lbs/day)	4,630	5,497	5,969	6,418	6,721	6,945	6,967
Primary Effluent BOD [(b)]	(lbs/day)	3,065	3,301	3,587	3,857	4,037	4,168	4,181
Secondary Biosolids [(c)]	(lbs/day)	4,598	4,951	5,380	5,786	6,055	6,253	6,272
Total Sludge / Biosolids	(lbs/day)	**9,228**	**10,448**	**11,349**	**12,204**	**12,776**	**13,198**	**13,239**
Total Nitrogen Load [(d)]	(lbs/day)	**266**	**301**	**327**	**352**	**369**	**381**	**382**

[(a)] Based on 77% TSS reduction in primary clarifiers.
[(b)] Based on 55% BOD reduction in primary clarifier.
[(c)] Based on sludge yield of 1.5 lbs biosolids per pound BOD applied
[(d)] Based on thickening and dewatering to 30% solids and TN of 150 mg/l in filtrate.

Table 3.32 Sludge/Biosolids Production without CEPT

		Year						
		2007	2010	2020	2030	2040	2050	2060
BOD Load (wet)	(lbs/day)	6,812	7,335	7,971	8,572	8,971	9,263	9,292
TSS Load (wet)	(lbs/day)	6,004	7,128	7,740	8,323	8,715	9,006	9,035
Primary Sludge Generation [(a)]	(lbs/day)	3,002	3,564	3,870	4,162	4,358	4,503	4,518
Primary Effluent BOD [(b)]	(lbs/day)	4,768	5,135	5,580	6,000	6,280	6,484	6,504
Secondary Biosolids [(c)]	(lbs/day)	7,153	7,702	8,370	9,001	9,420	9,726	9,757
Total Sludge / Biosolids	(lbs/day)	**10,155**	**11,266**	**12,240**	**13,162**	**13,777**	**14,229**	**14,274**
Total Nitrogen Load [(d)]	(lbs/day)	**293**	**325**	**350**	**380**	**397**	**410**	**412**

[(a)] Based on 50% TSS reduction in primary clarifiers.
[(b)] Based on 30% BOD reduction in primary clarifier.
[(c)] Based on sludge yield of 1.5 lbs biosolids per pound BOD applied
[(d)] Based on thickening and dewatering to 30% solids and TN of 150 mg/l in filtrate.

3.4.2.2. Pease WWTF

The Pease WWTF operates as a secondary process with primary clarifiers. It is assumed that biosolids and sludge production will increase proportional to the increase in projected BOD. The impact of this growth is presented in Table 3.33.

Table 3.33 Pease Sludge/Biosolids Production

		Year					
		2007	2010	2020	2030	2040	2050
BOD Load	(lbs/day)	2,340	2,546	3,233	3,920	3,920	3,920
% Increase over 2007			8.8%	38.2%	67.5%	67.5%	67.5%
Total Sludge / Biosolids	**(dry tons/yr)**	**160**	**174**	**221**	**268**	**268**	**268**

3.4.2.3.Regional WWTFs

To account for growth and the impact of more stringent discharge permit limits in the future, sludge and biosolids production at the regional facilities has been projected to increase by 50% in the year 2030. This factor is based on a 20% increase in biosolids yield due to increased BOD load associated with growth and a 30% increase in biosolids yield, assuming most regional WWTFs will implement BNR processes, resulting in higher biosolids yields.

Table 3.34 summarizes projected biosolids loads associated with Peirce Island WWTF, Pease WWTF and Regional WWTFs.

Table 3.34 Projected WWTF Sludge/Biosolids Production

Wastewater Facility	Sludge/Biosolids Produced (Annual Dry Tons)	
	2007	2030
Dover, NH	690	1,035
Durham, NH	420	630
Epping, NH (a)	0	0
Exeter, NH (a)	0	0
Farmington, NH	350	525
Hampton, NH	620	930
Newfields, NH	0	0
Newington, NH	50	75
Newmarket, NH	30	45
Rochester, NH (a)	0	0
Rockingham Cnty, NH (a)	0	0
Rollinsford, NH (b)	0	0
Seabrook, NH	210	315
Somersworth, NH (c)	480	720

Table 3.34 Projected WWTF Sludge/Biosolids Production

Wastewater Facility	Sludge/Biosolids Produced (Annual Dry Tons)	
	2007	2030
Berwick, ME	450	675
Kittery, ME	200	300
South Berwick, ME	600	900
York, ME	180	270
Pease WWTF	155	268
Peirce Island WWTF	845	1,760
TOTALS:	**5,280**	**8,448**

(a) Biosolids handled in lagoon system
(b) Included in South Berwick, ME data
(c) Estimated, data currently unavailable

Based on the above sludge/biosolids volumes, and assuming that sludge/biosolids would be brought to a regional facility the nitrogen component of the filtrate would reach an estimated 2,070 pounds per day in the year 2030, assuming 150 mg/l total nitrogen in the filtrate.

3.5. Septage Disposal Forecasting

Historic data utilized to develop septage disposal forecasting has been provided by the following sources:

- Operational data for the Pease WWTF, including septage receiving records, provided by the City.
- Data collected from phone surveys of the 16 New Hampshire and four Maine wastewater treatment facilities (WWTF) within the study area for 2006 and 2007.
- Data provided by the DES, which includes 2006 theoretical (estimated) septage and actual septage data for 2006 and 2007 within the study area.

Septage is generated when the septic tank of an on-site septic system is pumped and brought to a WWTF via private septic haulers. The City current only accepts septage at the Pease WWTF, and from non-sewered users in Portsmouth, and from Greenland, Newcastle and Rye.

In 2007, the City received approximately 1.6 million gallons of septage from these four communities. The New Hampshire Department of Environmental Services (DES) tracks septage disposal by town. In contrast, the four communities which disposed of septage at the Pease WWTF generated approximately 2.2 million gallons of septage in 2007, or 600,0000 gallons more than was disposed of at the Pease WWTF. This discrepancy is due in part to the fact that while the City only accepts septage from the four communities utilizing the service, the private septic hauler can dispose of septage at any WWTF willing to accept it. In recent years, the South Berwick, Maine WWTF has positioned itself as a regional septage disposal facility, and by offering favorable disposal rates, received over 10 million gallons of septage in 2007, three (3) million gallons of which came from New Hampshire communities.

The NHDES currently has a grant program in place which provides for a 2% grant for each community with which a grantee formulates an agreement to accepts its septage, up to a maximum grant of 50%. The City is currently eligible for a 30% baseline grant, therefore, an additional 20% grant could be obtained for septage receiving and treatment, if the City were to seek formal agreements with 10 towns. The septage grant can be applied to all aspects of the WWTF affected by the receiving of septage, based on the following septage characteristics:

- BOD = 7,000 mg/L
- TSS = 15,000 mg/L
- NH3 -N = 150 mg/L

3.5.1. Septage Generation Scenarios

Five (5) septage generation scenarios for the planning of a potential septage receiving and handling facility have been evaluated. Each Scenario presents the current estimated annual septage volumes for municipalities within the seacoast study area as identified in TM-1. These volumes will be used as a baseline for septage generation and loading scenarios and will be adjusted based on the development projections presented in this memorandum for the planning period.

The data presented includes the estimated residential septage generation data for 2006 and actual reported data of residential/commercial septage for 2006 and 2007. This data was developed by the staff of NHDES as part of other ongoing state planning efforts. The estimated septage data generated by NHDES from each municipality was calculated using the number of households with septic systems within the municipality and assuming the average 1,000 gallon tank is pumped every 5 years. The information was based on planning level details for the number of households and population data from the State Office of Energy and Planning (OEP). The estimated septage represents only domestic generated septage (residential) and is only included as a comparison to the actual reported septage quantities.

The actual reported septage generated from each municipality was compiled from reports submitted by the regional septage haulers licensed to pump, haul, and dispose of septage. Based on input from NHDES staff, it is believed that this data more accurately reflects the total amount of septage generated from each municipality. It should be noted that, in general, the septage volumes reported during 2007 decreased from 2006. There are several factors responsible for the decrease in septage during 2007, including the slow down in the economy which may have discouraged people from pumping septage as often as recommended, and some of the 2007 data may not have been received by the NHDES at the time we were provided the data. In general the 2007 and 2006 actual reported septage volumes are consistent. In addition, these actual volumes are reasonably consistent with respect to the residential generation estimates developed by NHDES for those communities that are non-commercially intensive.

The following scenarios have been developed based on the highest value of 2006 or 2007.

3.5.1.1.Scenario A – Septage Generated from Portsmouth

Scenario A presents septage data only from the City of Portsmouth. The annual septage generation quantity for Scenario A is 921,000 gallons.

3.5.1.2.Scenario B – Septage Generated from Local Seacoast Municipalities

This scenario presents septage data from the City of Portsmouth and the six (6) local municipalities surrounding Portsmouth. These municipalities were identified in TM-1 and include Greenland, Newcastle, Newington, North Hampton, Rye, and Stratham. The City already receives septage from Greenland, Newcastle and Rye. The annual septage generation for Scenario B is 4,133,000 gallons

3.5.1.3.Scenario C – Septage Generated from Local Seacoast Municipalities to Achieve Maximum Funding

This scenario presents septage data from the City of Portsmouth, including the six (6) local municipalities identified in TM-1, and additional municipalities to achieve the maximum amount of state funding to construct the septage receiving facility.

In addition to the six (6) municipalities identified in Scenario B, four (4) additional municipalities were added to increase the amount of potential funding assistance to the maximum of 50%. Portsmouth currently is eligible for a base 30% grant for wastewater related facilities. Therefore, with the ten (10) additional communities identified, Portsmouth could reach the 50% grant maximum (30% base + 2%x10 = 50%).

The additional four (4) municipalities selected are Hampton Falls, Kensington, Lee, and Madbury. These towns were selected on the basis that they do not currently have a municipal WWTP and the proximity to Portsmouth. No other factors were considered in the selection of these municipalities including political or economic factors at this time.

The annual septage generation for Scenario C is 4,955,000 gallons.

3.5.1.4.Scenario D – Septage Generated from all Study Area Municipalities w/out WWTFs

This scenario presents septage data from the City of Portsmouth, including all the study area municipalities without wastewater treatment facilities. Including Portsmouth this Scenario includes 30 municipalities.

The annual septage generation for Scenario D is 15,046,000 gallons.

3.5.1.5.Scenario E – Septage Generated from all Study Area Municipalities

This scenario presents septage data from the City of Portsmouth and all of the study area municipalities. Including Portsmouth this Scenario includes 44 municipalities.

The annual septage generation for Scenario E is 20,899,000 gallons.

3.5.2. Septage Receiving Needs

Based on historic data for septage receiving at the Pease WWTF, the annual distributing of septage is as follows:

Month	% of Total Septage Received
Jan	7%
Feb	7%
Mar	7%
Apr	8%
May	8%
Jun	10%
Jul	9%
Aug	10%
Sep	11%
Oct	11%
Nov	5%
Dec	6%

During the months of September and October the highest volume of septage is received at the Pease WWTF. Assuming this trend continues in the future, the septage receiving capacity for a regional septage facility is presented in Table 3.20, based on 3,000 gallon septage trucks.

A single commercially available septage receiving system can operate at 400 gallons per minute (gpm) maximum, and at a recommended rate of 200 gpm maximum. In addition, time must be allowed for the truck operator to connect and disconnect the truck, wash down, and perform administrative tasks for billing. In general, an allowance of 20 minutes for a 3,000 gallon septage truck is an acceptable timeframe from facility entrance to exit.

With the time frames projected in Table 3.35, a single commercial septage receiving system, operating 14 hours per day would meet the needs of all scenarios.

Table 3.35 Septage Receiving Capacity Requirements

	Septage Gallons				
Scenario	Projected Annual	Peak Month	Per Day	Trucks per Day	Discharge Time Required
					(hrs)
A	921,000	101,310	5,065	2	0.6
B	4,133,000	454,630	22,730	8	2.6
C	4,955,000	545,050	27,250	10	3.1
D	15,046,000	1,655,060	82,750	28	9.2
E	20,899,000	2,298,890	114,940	38	12.8

The nutrient impact of septage receiving, assuming that the septage is treated as a biosolid, in that the material is dewatered and only the filtrate is introduced to the biological process, is summarized in Table 3.36.

Table 3.36 Septage Contribution to Total Nitrogen Loading

	Total Nitrogen Load		
Scenario	Dewatered Filtrate	Drier Condensate	Total
	(lbs/day)	(lbs/day)	(lbs/day)
A	1,142	152	1,294
B	5,126	684	5,810
C	6,146	819	6,965
D	18,663	2,488	21,151
E	25,923	3,456	29,379

3.6. Fats, Oils and Grease

NH FOG Study & Generation

In 2006 the New Hampshire Legislature passed HB 1373 which established a "Commission" to study fats, oils, and greases (FOG) generation and to recommend best management practices for FOGs. The Commission was comprised of various entities within the State of NH including representatives from the state government (Speaker of the House and Senate President), Department of Environmental Services (NHDES), NH Association of Septage Haulers, NH Lodging and Restaurant Association, NH Water Pollution Control Association, and the University of New Hampshire.

FOG is commonly derived from food products such as deep-fried foods, meats, sauces, gravy, dressings, baked goods, cheeses, and butter. Food-derived FOG can end up going down the drain and ultimately into the sewer system during the cleaning of plates, pots and pans to remove food residue or by improper disposal of leftovers or grease. Once inside the sewer FOG can form a thick layer on the inside of pipes blocking sewage from traveling through the sewer pipe.

Weston & Sampson has reviewed this report and is basing its FOG generation rates from the data provided within the report. The Report titled *Commission to Study Ways to Encourage Proper Recycling and Disposal of Grease Trap Wastes and to Develop Additional Disposal Capacity* was finalized November 1, 2007.

The commission was conducted to study and provided recommendations on the handling of wastewater greases. The report cites a grease generation rate from *Urban Waste Grease Resource Assessment*, published by the US Department of Energy (1998). According to this report, the "combined resources of collected grease trap waste and uncollected grease entering the sewage treatment plants **ranged from about 2 to 27 pounds/person/year**" and the weighted **average is approximately 13.4 pounds of grease/person/year** (Wiltsee, 1998).

The commission then estimated the NH grease or FOG generation based on the 2006 state population. The following figure is from the Commission's report.

Estimated Grease Generation in NH

2006 NH Population **1,314,895** x **13.4** pounds of grease/person/year = **17,619,593** pounds/year

Convert to Gallons

17,619,593 Pounds of grease/year ÷ **8.34** pounds/gallon = **2,112,661** gallons/year

Source: Commission to Study Ways to Encourage Proper Recycling and Disposal of Grease Trap Wastes and to Develop Additional Disposal Capacity, November 1, 2007

The commission's report stated that the estimated 2.1 million gallons per year is probably a conservatively low figure because New Hampshire has a seasonally high tourist population that increases the actual grease generation rates. This is even more evident for Portsmouth, which has a higher than average restaurant density and tourist population. However the Commission felt that the annual value was appropriate for planning purposes.

FOG Disposal

The Commission also compiled FOG disposal data for New Hampshire. Unfortunately, data is not readily available for NH disposal and currently detailed recordkeeping is non-existent. Therefore, to estimate FOG disposal in New Hampshire, all known disposal outlets in the New England region were contacted through a phone survey in the summer of 2007. As with any survey, the results may have a wide range of accuracy. The survey results which come directly from the Commission's Report are presented below.

NH Grease Disposal in 2006

Disposal Location		Quantity (Gallons)
Baker Commodities Inc. (Corenco)	Billerica, MA	100,000
EarthSource Wastewater Facility	Raynham, MA	225,000
Merrimack WWTF	Merrimack, NH	166,422
Milford Wastewater Treatment Facility	Milford, NH	6,000
Northeast Environmental Processing	Lawrence, MA	47,460
Pat Jackson, Inc./Tri-City Septic	Augusta, ME	10,000
Suburban Contract Cleaning, Inc	Rochester, MA	125,000
South Berwick (ME) WWTF	South Berwick, ME	439,067
Stewart Septic Service, Inc.	Bradford, MA	745,900
Suncook Wastewater Treatment Facility	Allenstown, NH	582,150
	Total:	**2,446,999**

Source: Commission to Study Ways to Encourage Proper Recycling and Disposal of Grease Trap Wastes and to Develop Additional Disposal Capacity, November 1, 2007

In 2006, the commission reported that grease generated in New Hampshire went to 10 disposal locations throughout the region. A total of 2.4 million gallons was disposed from NH during 2006. For comparison, the number of gallons disposed (2.4 million) is relatively similar to the estimated average number of gallons of FOG generated (2.1 million). This is important because it provides some validation for the use of the generation rates numbers when evaluating the Seacoast area for FOG generation.

Seacoast Area FOG Generation

Because actual FOG generation data is difficult to gather and compile, it is proposed to use the generation rates provided in the Commission's Report for the purpose of this Master Plan. The following assumptions were considered during the calculation of Seacoast Area FOGs.

- FOG Generation rate range shall be 2 to 27 lbs/person/yr. The average is a straight average based on the low and high generations.
- The average of the low and high generation shall be used for the Seacoast Area with the exception of Portsmouth which use the maximum generation rate due to its high tourist population.

NH FOG Generation

Study Area	Population	FOG Generation Rates (lbs/person/yr)		Estimated FOG Generated (gal/yr)		
		Low	High	Low	High	Average
State of NH	1,314,895	2	27	315,323	4,256,854	2,286,088
Portsmouth	20,995	2	27	5,035	67,969	36,502
Seacoast w/out Portsmouth	273,968	2	27	65,700	886,947	476,323
Seacoast including Portsmouth	294,963	2	27	70,735	954,916	512,825

Notes: The population data for entire state of NH is from the 2006 census, the populations for the Seacoast and Portsmouth is from 2005.

Weston & Sampson recommends the following annual FOG range of loading for the Seacoast Area Municipalities.

- **Portsmouth: 68,000 gal/yr FOG Generated** (Portsmouth high rate)
- **All Seacoast Municipalities: 545,000 gal/yr FOG Generated** (Seacoast average + Portsmouth high)

References:

State of NH (November 1, 2007), *Commission to Study Ways to Encourage Proper Recycling and Disposal of Grease Trap Wastes and to Develop Additional Disposal Capacity*

NH Office of Energy and Planning, 2005 population data

3.7. Summary

Tables 3.37 and 3.38 summarize the current and projected flows and loads for the Peirce Island, Pease WWTF, as well as the study area.

Table 3.37 Current Conditions Summary

Population [(a)]	20,811
Employment [(a)]	28,768
Peirce Island WWTF Flows and Loads	
Sanitary Flow, mgd [(b)]	2.60
Total Wet Weather Flow, mgd [(c)]	8.75
BOD, lbs/d [(d)]	6,812
TSS, lbs/d [(d)]	6,004
TN, lbs/d [(d)]	3,000
Sludge Yield, lbs/d [(e)]	4,630
Pease WWTF Flows and Loads	
Sanitary Flow [(d)] mgd	0.41
Wet Weather Flow [(d)(f)] mgd	0.59
BOD, lbs/d [(d)]	2,137
TSS, lbs/d [(d)]	2,337
Sludge/Biosolids Yield, lbs/d	2,340

(a) Source: New Hampshire Office of Energy and Planning
(b) Includes all tributary sanitary flows
(c) Does not include CSO flows
(d) Based on 2007 data, includes septage
(e) Includes chemical sludge
(f) Includes sanitary flow and I/I

Table 3.38 Future Conditions Summary

	Year					
	2010	2020	2030	2040	2050	2060
Population	21,320 [(a)]	22,730 [(a)]	24,390 [(a)]	25,881 [(b)]	27,373 [(b)]	27,450 [(b)]
Employment	29,919 [(c)]	32,796 [(c)]	35,672 [(c)]	38,549 [(c)]	41,426 [(c)]	44,239 [(c)]
Peirce Island WWTF Flows and Loads						
Sanitary Flow [(d)] mgd	2.68	3.14	3.49	3.65	3.80	3.86
Wet Weather Flow [(e)] mgd	8.83	9.29	9.64	9.80	9.95	10.01
BOD, lbs/d [(f)]	7,266	7,758	8,223	8,647	9,072	9,234
TSS, lbs/d [(f)]	7,064	7,542	7,998	8,413	8,828	8,981
TN, lbs/d [(f)]	3,230	3,510	3,775	3,950	4,080	4,090
Sludge/Biosolids Yield, lbs/d [(g)]	10,448	11,349	12,204	12,776	13,198	13,239
Pease WWTF Flows and Loads						
Sanitary Flow [(d)] mgd	0.47	0.68	0.88	1.09	1.30	1.51
Wet Weather Flow [(h)] mgd	1.00	1.21	1.41	1.62	1.83	2.04
BOD, lbs/d [(f)]	2,340	2,675	3,009	3,343	3,676	4,010
TSS, lbs/d [(f)]	2,314	2,645	2,975	3,305	3,635	3,965
Sludge/Biosolids Yield, dry ton/yr [(i)]	160	174	221	268	268	268
Regional WWTFs						
Sludge/Biosolids Yield, dry ton/yr [(i)(j)]	-	-	6,420	-	-	-
Septage						
Minimum Annual (1,000 Gallons) [(k)]	921					
Maximum Annual (1,000 Gallons) [(l)]	20,900					

(a) Source: New Hampshire Office of Energy and Planning
(b) Assumes the average growth rate of the New Hampshire Office of Energy and Planning forecasts continues beyond 2030 until reaching the buildout population of 27,450 (see Section 3.5) in the year 2051.
(c) Medium growth employment forecast: 1.0% annual growth rate. Employment reaches buildout level of 44,239 in the year 2054
(d) Based on medium employment growth rate. Includes all tributary sanitary flows.
(e) 10 – Year maximum month, medium employment growth, does not include CSO flows
(f) Based on medium employment growth.
(g) Assumes CEPT is utilized, based on secondary biosolids yield of 1.5 lbs/lb BOD
(h) 10 – Year maximum month, medium employment growth
(i) Assumes sludge/biosolids yield increases with influent BOD
(j) Does not include Pease or Peirce Island WWTFs
(k) Scenario A
(l) Scenario E

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 1
1 Congress Street, Suite 1100
BOSTON, MA 02114-2023

Memorandum

Date: March 30, 2009

Subject: TM 3 Report – Tasks 4 and 5 Status

From: Joy Hilton

I called and left a message for Peter Rice at 3:15 p.m. on March 30, 2009 and asked him to return my call. I said that neither NHDES nor EPA have comments on the TM3 Report. Also, I asked for a progress report (see Tasks 4 and 5 of the Scope of Work dated 5/23/07).

City of Portsmouth, New Hampshire

Wastewater Master Plan

Technical Memorandum

TM 3

FLOWS AND LOADS – EXISTING AND FORECASTED CONDITIONS

Tasks:	3.1 through 3.5	
Status:	~~First Draft~~	~~4/16/08~~
	~~Submitted to EPA~~	~~4/29/08~~
	~~Final Submission to EPA / DES~~	~~5/30/08~~
	Final/Final Submission to EPA / DES	**6/12/08**

3.1. Introduction and Purpose

This Technical Memorandum (TM) was prepared to satisfy the requirements of Task 3 as set forth in the Work Plan for the City of Portsmouth, New Hampshire Wastewater Master Plan (WMP). This TM evaluates flows and loads under existing and forecasted conditions. Further, the potential for additional septage, biosolids, and fats, oil and grease (FOG) handling capacity is also evaluated. Each task associated with Task 3 of the Work Plan is addressed below.

The loads analyzed by this WMP include biochemical oxygen demand (BOD), total suspended solids (TSS), and total nitrogen. The National Pollutant Discharge Elimination System (NPDES) Permit for the City's two wastewater treatment facilities (WWTFs) regulates the treatment and discharge of these as well as other pollutants.

The flow and load forecasts presented in this TM were developed primarily to estimate future wastewater treatment and disposal needs. To this end, the flows and loads will be discussed in terms of City-wide contributions, or contributions specifically to the Peirce Island or Pease WWTF. In the future, the flow forecasts will be revisited as additional flow meter data becomes available throughout the collection system.

A software package developed by Brown and Caldwell, the Capacity Assurance Planning Environment (CAPE) model, was used to assist with the development of the wastewater flow and load forecasts. CAPE is GIS-based application developed for wastewater master planning. It performs tasks such as estimating population and employment distributions, developing buildout forecasts, analyzing water usage data and performing wastewater forecasts.

3.2. Planning Horizon and Study Area

The period of time over which a study evaluates conditions is known as its planning horizon. Working within an established planning horizon ensures that decisions made today take into account the needs of tomorrow and result in solutions that are scalable and sustainable in the long-term.

Different planning horizons have been identified for different types of infrastructure and their expected useful lives. The planning horizon for the WWTFs extends to the year 2030 which is approximately a 20 year planning period. Additionally, the WWTF sites will be evaluated for sustaining flow based expansions through the year 2060. The planning horizon for the collection system infrastructure extends through the year 2060 which is approximately a 50 year planning period.

In addition to looking at conditions through 2030 and 2060, the WMP also analyzed the maximum level of development expected in the City. This level of development is referred to as "buildout" conditions. Buildout conditions were used to evaluate the potential for growth in the City and to ensure that planned infrastructure would be properly sized for all future conditions.

The Study Area has been divided into several categories based on categories of wastewater service.

Sanitary Sewer Service

The Sanitary Sewer Service area includes the City of Portsmouth and the following communities which currently discharge wastewater to the Portsmouth wastewater collection system: Greenland, Newcastle, and Rye. It also includes the following communities which have the potential to discharge to the City's system in the future: North Hampton, Stratham, Newington, and Pease Development Authority which oversees activities at the Pease International Tradeport.

Only a small portion of Greenland is currently served. This service is provided through a private agreement with the property owner in Greenland and not via an inter-municipal agreement between Greenland and Portsmouth.

Rye has an inter-municipal agreement with Portsmouth for sewer service.

Based on past studies, the Route 1 corridor in North Hampton may require sewering to the Hampton border at some time in the future.

Biosolids Handling

The Biosolids Handling Service Area includes the City of Portsmouth and potentially all 44 communities in the Seacoast Regional Wastewater Management Study, as well as select WWTFs in Maine, including Kittery, York and South Berwick.

Fats, Oils and Grease

The FOG Service Area includes the City of Portsmouth and potentially all 44 communities in the Seacoast Regional Wastewater Management Study.

Septage

The Septage Service Area includes the City of Portsmouth and potentially all 44 communities in the Seacoast Regional Wastewater Management Study.

3.3. Review of Historical Flows and Loads

Historical flow and loads data were collected and analyzed. This data will be used in Section 3.6 to calibrate the wastewater flow and loading rates for the forecasting model.

3.3.1. Wastewater Treatment Facilities

This section presents the historical flows and loads for the Peirce Island and Pease WWTFs.

3.3.1.1.Flows

Influent flow data to the WWTFs was collected from monthly operating reports. The data is presented in the sections that follow.

Peirce Island Wastewater Treatment Facility

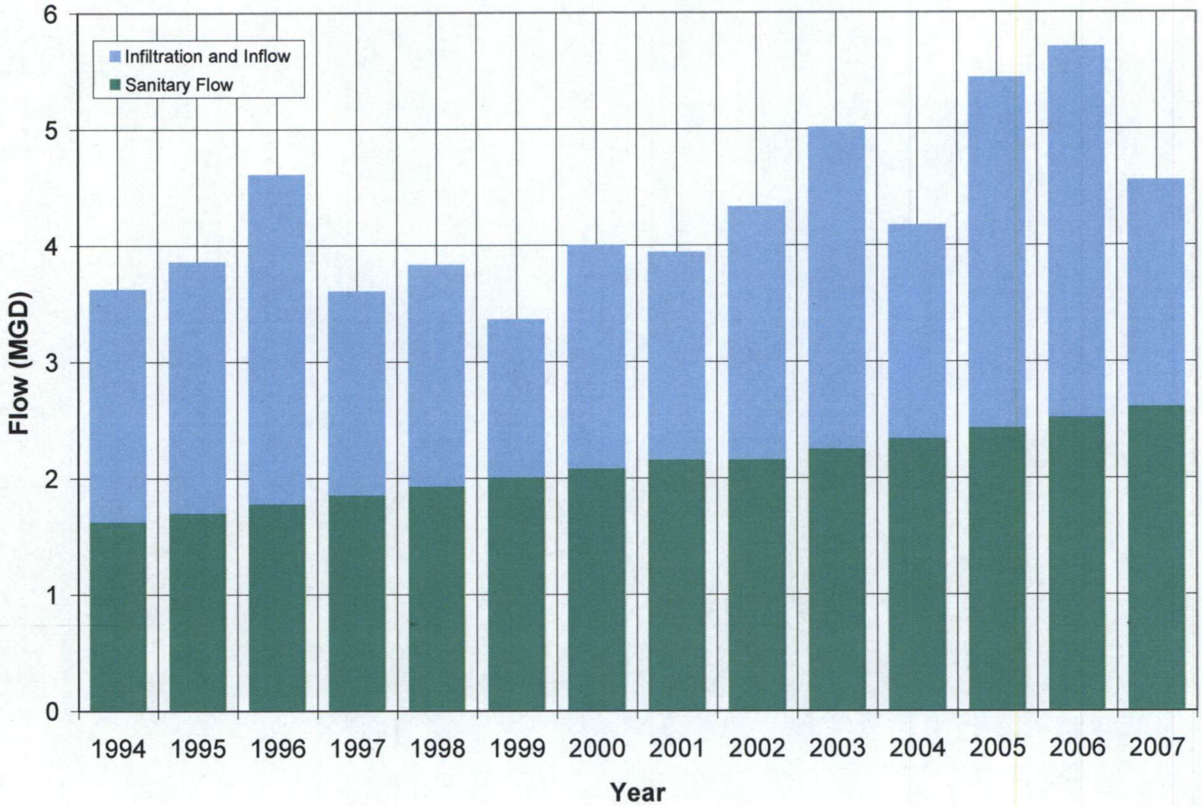
Flow records dating back to 1994 were collected for the Peirce Island WWTF. The average annual flow at the Peirce Island WWTF is shown in Table 3.1.

The average annual flow is also plotted in Figure 3.1. The flows shown in Figure 3.1 have been disaggregated into sanitary flow and an infiltration and inflow (I/I) components. The sanitary flow component was estimated from City water use records. Annual water use in Portsmouth (excluding Pease) was 2.06 MGD in 1997, 2.40 MGD in 2002, and 2.90 MGD in 2007. It was assumed that 90% of the water use is returned as wastewater. As a result, the estimated sanitary wastewater was 1.85 MGD in 1997, 2.16 MGD in 2002, and 2.60 MGD in 2007. The I/I component was estimated by subtracting the sanitary flow component from the total measured flow. The I/I component includes combined flows with the exception of that which are discharged through the City's permitted combined sewer overflows (CSOs). The combined flows discharged from the CSOs are not shown in the figure.

Table 3.1 Average Annual Flow at the Peirce Island WWTF

Year	Flow (MGD)
1994	4.80
1995	4.96
1996	5.64
1997	4.56
1998	4.71
1999	4.16
2000	4.72
2001	4.59
2002	4.98
2003	5.57
2004	4.64
2005	5.81
2006	5.99
2007	4.75

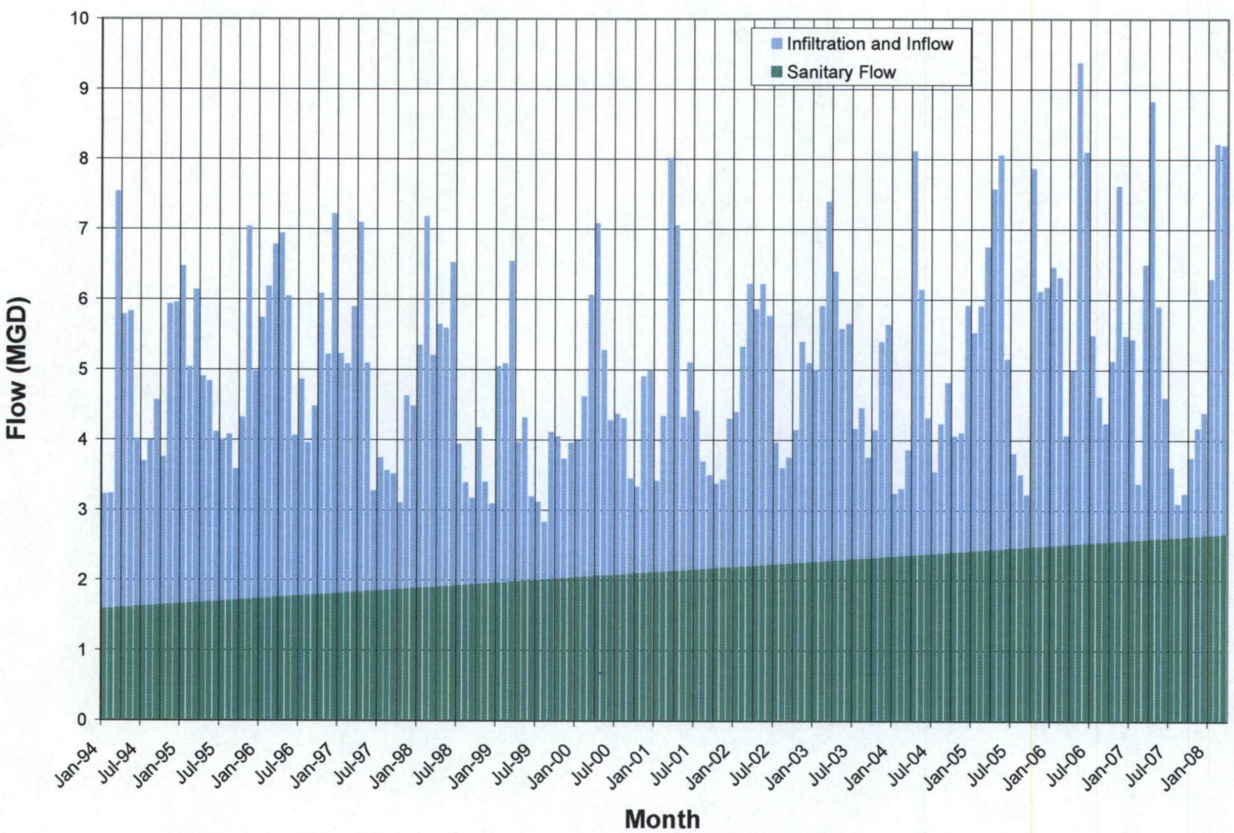
Figure 3.1 Average Annual Flow at the Peirce Island Wastewater Treatment Facility(1)



Notes: 1. Sanitary flow component estimated using water use records from 1997, 2002, and 2007.

The average monthly flow at the Peirce Island WWTF is shown in Figure 3.2. As with Figure 3.1, the flows have been disaggregated into sanitary flow and I/I components.

Figure 3.2 Average Monthly Flow at the Peirce Island Wastewater Treatment Facility(1)



Notes: 1. Sanitary flow component estimated using water use records from 1997, 2002, and 2007.

I/I can vary significantly depending upon hydrologic conditions. In order to determine the range and likelihood of different levels of I/I occurring in the collection system, a statistical analysis was performed.

The likelihood (or probability) that a certain I/I flow will be exceeded is referred to as its return period and is often expressed in years. The goal of the statistical analysis is to determine the return period for different levels of flow. For example, a 10-year peak month flow is the average monthly flow which is exceeded once every 10 years on average. The probability that the flow will be exceeded in any given year is determined by taking the inverse of the return period. For example, the 10-year peak month flow has a 10% chance of being exceeded once every 10 years.

Understanding the likelihood of certain flows occurring in the collection system and at the WWTPs is an essential component of risk-based design. For example, a WWTP with a NPDES maximum monthly flow limit equal to the 10-year peak month flow would be expected to exceed the flow-based permit limit once every 10 years on average[1].

The statistical analysis was performed on the I/I component of the wastewater flow. It evaluated the maximum average annual and maximum monthly I/I. The statistical analysis was performed in accordance with the standards developed and employed within the hydrologic community for analyzing extreme events (i.e., floods and droughts).

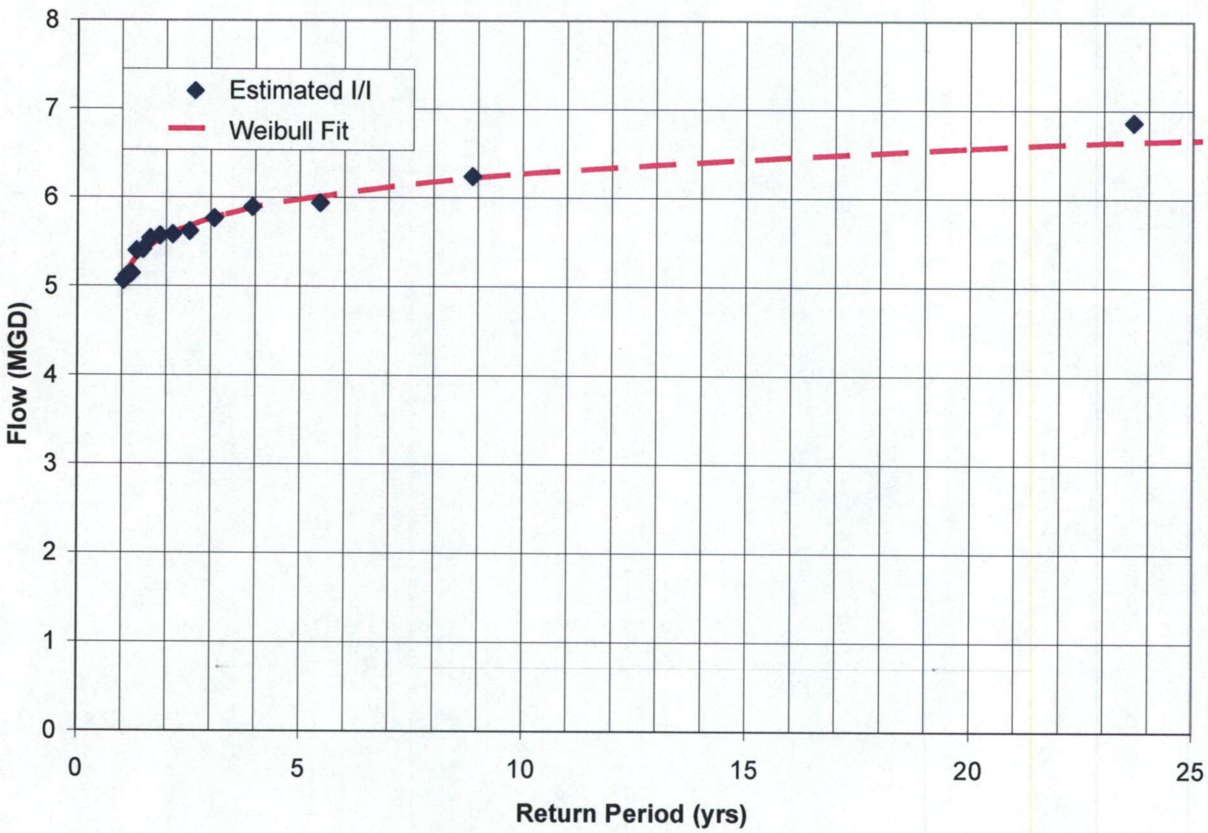
In the first step of the statistical analysis a probability distribution is fit to the largest average annual and maximum monthly I/I. A number of probability distributions have been developed and used extensively for characterizing high flow events by the hydrologic community. These distributions include the lognormal, Log-Pearson Type 3, and Weibull distribution. All three of these distributions returned similar results for the I/I at the Peirce Island WWTP. Due to its ease of implementation, the Weibull distribution was selected as the preferred distribution.

The maximum monthly I/I exceedance frequencies for the Peirce Island WWTP are shown in Figure 3.3. The return period shown along the x-axis indicates how often the flow is expected to be exceeded in years. The dashed line shows the return period based on the Weibull distribution. For comparison purposes, the maximum monthly I/I estimated from the WWTP measurements are also shown in the figure. The return period for these values was determined using another technique employed in hydrology called plotting position. There are a number of different plotting position techniques that have been developed. One of the most popular is the unbiased Cunnane plotting position. The Cunnane plotting position was used to plot the maximum month I/I estimated from the WWTP measurements.

The average annual infiltration and inflow recurrence frequencies are shown in Figure 3.4.

[1] Currently the Peirce Island WWTP must report average annual and monthly flows, but no limits have been set under the Interim Standards as set forth in the Administrative Order dated August 1, 2007.

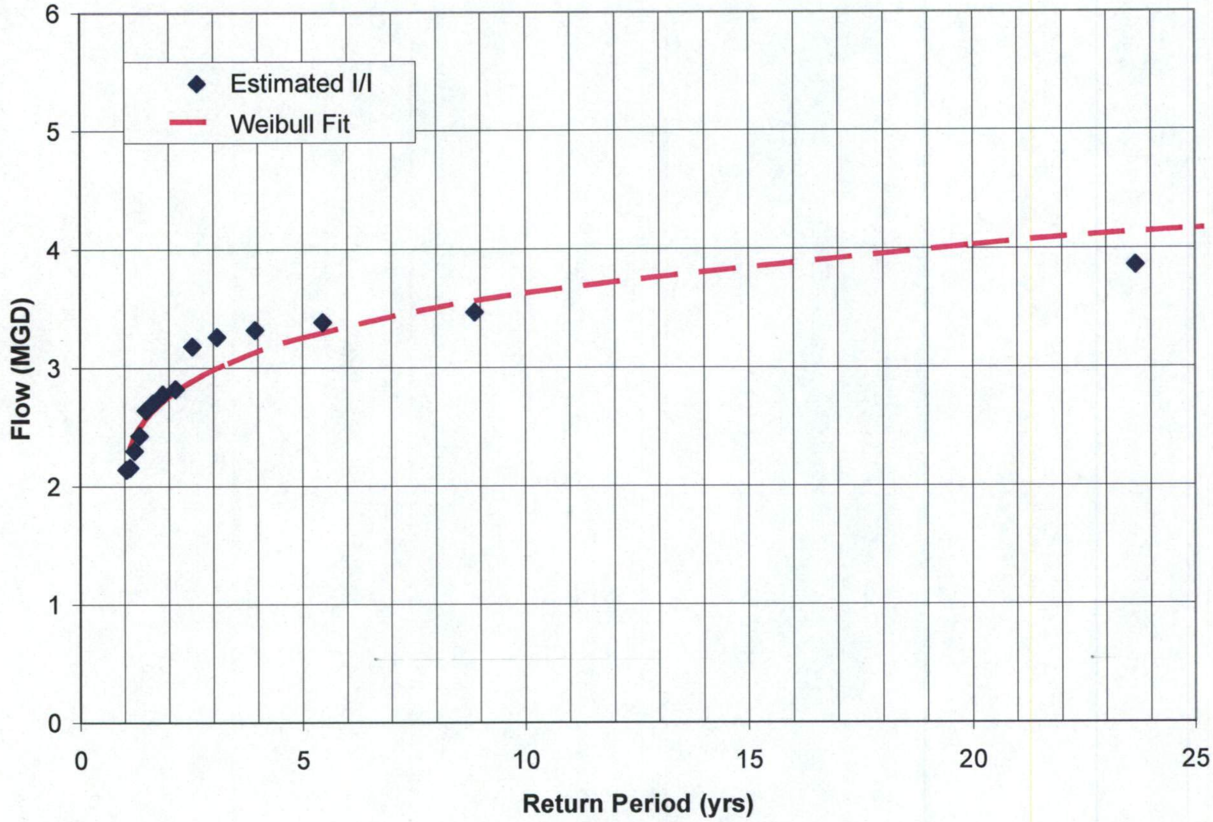
Figure 3.3 Peirce Island WWTF Maximum Monthly I/I Recurrence Frequencies (1)



Notes:

1. Results of statistical analysis of I/I to the Peirce Island WWTP (see Figure 3.1). The I/I values used in the analysis were estimated from flow measurements to the Peirce Island WWTP. A Weibull distribution was fit to the I/I values (dashed line). The I/I estimated from the WWTP measurements (blue diamonds) are plotted using the Cunnane plotting position.

Figure 3.4 Peirce Island WWTF Average Annual I/I Recurrence Frequencies (1)



Notes:

1. Results of statistical analysis of I/I to the Peirce Island WWTP (see Figure 3.2). The I/I values used in the analysis were estimated from flow measurements to the Peirce Island WWTP. A Weibull distribution was fit to the I/I values (dashed line). The I/I estimated from the WWTP measurements (blue diamonds) are plotted using the Cunnane plotting position.

The estimated 2, 5, 10, and 20-year flows at the Peirce Island WWTF are shown in Table 3.2. In addition to showing the I/I, the total flow (i.e., sanitary flow plus I/I) has also been included in the Table.

Table 3.2 Estimated Flow Recurrence Frequencies at the Peirce Island WWTF

Return Period (years)	I/I (MGD)		Sanitary flow Plus I/I (MGD)	
	Average Annual	Maximum Monthly	Average Annual	Maximum Monthly
2	2.8	5.6	5.4	8.2
5	3.2	6.0	5.8	8.6
10	3.6	6.3	6.2	8.9
20	4.0	6.6	6.6	9.2

Rye, Greenland, and Newcastle discharge wastewater to the City's collection system. Table 3.3 estimates how much wastewater is contributed by each community. The Table shows the sanitary flow and I/I components as well as the total flow. The values shown in Table 3.3 represent the I/I component with an estimated exceedance frequency once every 10 years.

Table 3.3 Peirce Island WWTF Flows by Source

Source	Flow (gallons/day)						
	Sanitary flow	I/I (1)			Total (Sanitary flow plus I/I)		
		Avg Annual	10 Year Exceedance Flow (2)		Avg Annual	10 Year Exceedance Flow (2)	
			Max Avg Annual	Max Month		Max Avg Annual	Max Month
Portsmouth	2,525,000	264,000 (1)	3,592,500 (1)	6,176,250 (1)	2,789,000	6,117,500	8,701,250
Rye	7,500 (3)	2,500 (3)	3,750 (4)	9,375 (5)	10,000	11,250	16,875
Greenland (7)	10,000	0	0	0	10,000	10,000	10,000
New Castle	67,500 (6)	22,500 (6)	33,750 (4)	84,375 (5)	90,000	101,250	151,875
Total (8)	2,600,000	289,000	3,630,000	6,270,000	2,889,000	6,230,000	8,870,000

Notes:
1. Includes combined flow with the exception of combined flows discharged as CSOs.
2. Flow likely to be exceeded once every 10 years on average (10% probability of exceedance in any given year).
3. Average annual flow is estimated at 10,000 gpd. Data was not available to develop a detailed estimate of the portion of the flow which is sanitary versus I/I. Using engineering judgment, it was assumed that 75% of this flow is sanitary flow.
4. Data was not available to statistically determine the 10-Year Max Average Annual I/I. Based on engineering judgment, it was assumed that the 10-Year Max Average Annual I/I is 1.5 times greater than the Average Annual I/I.
5. Data was not available to statistically determine the 10-Year Max Month I/I. Based on engineering judgment, it was assumed that the 10-Year Max Month I/I is 2.5 times greater than the 10-Year Max Average Annual I/I.
6. Average annual flow is estimated to be 90,000 gpd. Data was not available to develop a detailed estimate of the portion of the flow which is sanitary versus I/I. Using engineering judgment, it; assumed that 75% of this flow is sanitary flow.
7. Estimated average annual flow is 10,000 gpd; flow is discharged to a force main and is assumed to be all sanitary flow with no I/I component.
8. Total flow to the Peirce Island WWTF; values developed from data measured from 1994 - 2007.
9. See Figure 3.4.
10. See Figure 3.3.

Pease Wastewater Treatment Facility

Flows from 2004 through 2007 were collected for the Pease WWTF. The average monthly flows are shown in Figure 3.5 while the average annual flows are shown in Figure 3.6.

Wastewater flows to the Pease WWTF changed from 2004 through 2007 due to changes in the Pease Development Authority's industrial customer base. For example, there were several significant industrial expansions. As a result, it was difficult to estimate the variation in the base sanitary flow component during this time. Accordingly, the measured flows, as shown in Figures 3.5 and 3.6, were not disaggregated into sanitary flow and I/I components as they were for the Peirce Island WWTF flows as shown in Figures 3.1 and 3.2.

However, while no attempt was made to characterize the historic variation in sanitary flow, the current sanitary flow was estimated. Based on the monthly flow data from 2007, it is estimated that the current sanitary flow to the Pease WWTF is 410,000 gpd. The average annual flow for 2007 was 586,000 gpd. Accordingly, the average annual I/I for 2007 was approximately 176,000 gpd.

A statistical analysis of the I/I was not performed for the Pease WWTF. The statistical analysis requires many data points for the results to be reliable. For Peirce Island, the 14 years of historical data provided a solid foundation for the analysis. However, for the Pease WWTF, the uncertainty in the historical sanitary flow data made it difficult to develop a historic record of I/I. As a result, there is not enough data to perform a reliable statistically analysis.

Figure 3.5 Average Monthly Flow at the Pease Wastewater Treatment Facility

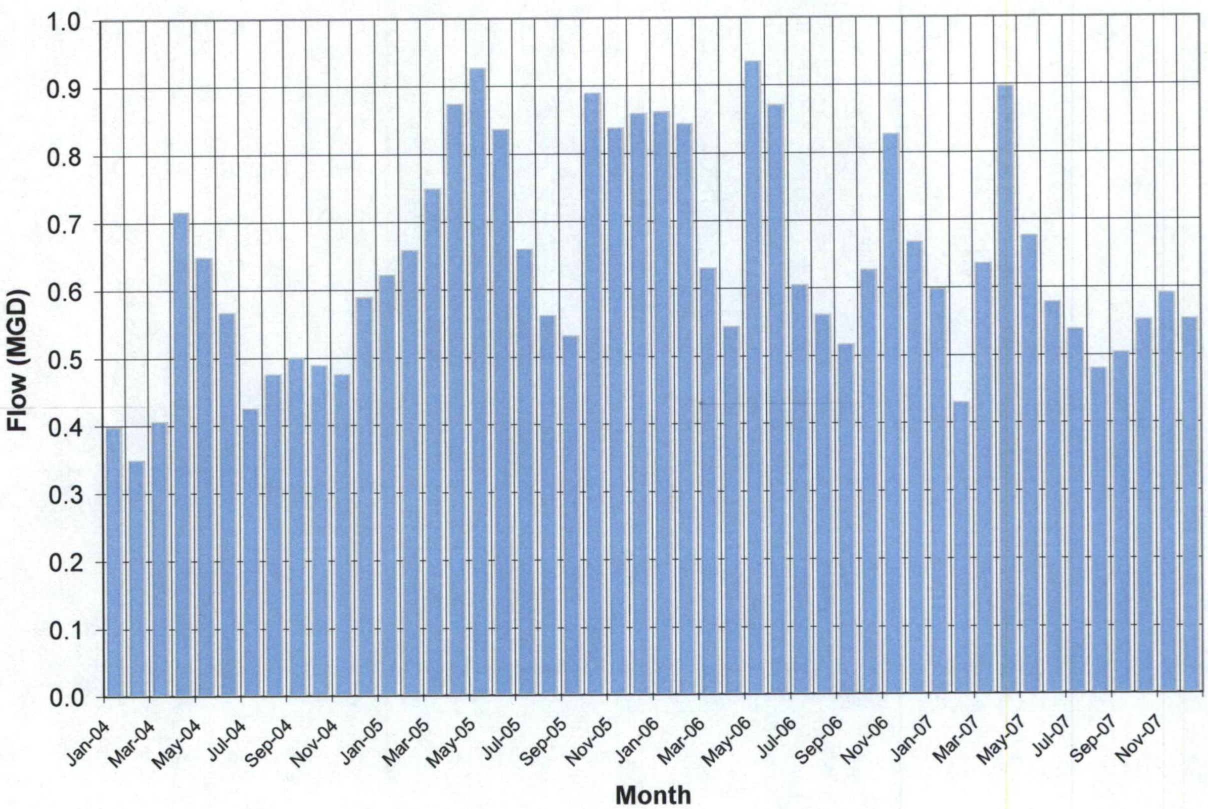
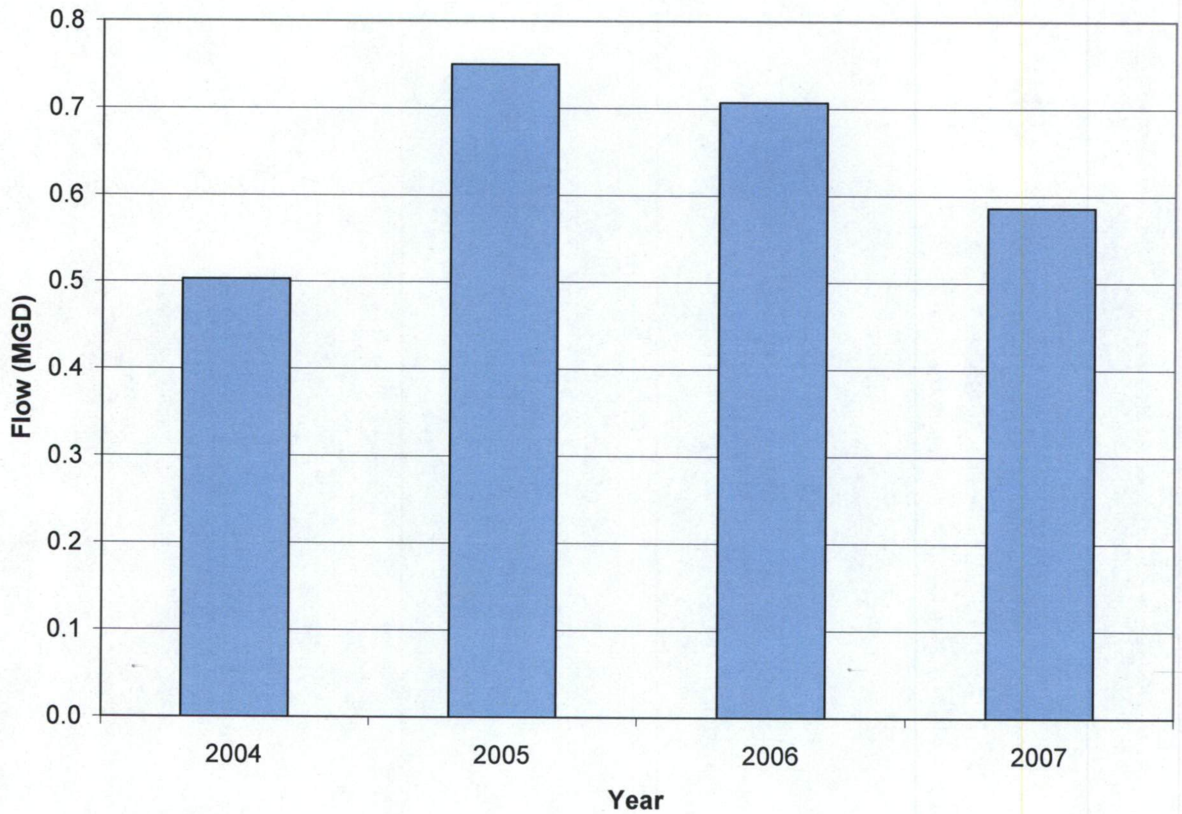


Figure 3.6 Average Annual Flow at the Pease Wastewater Treatment Facility

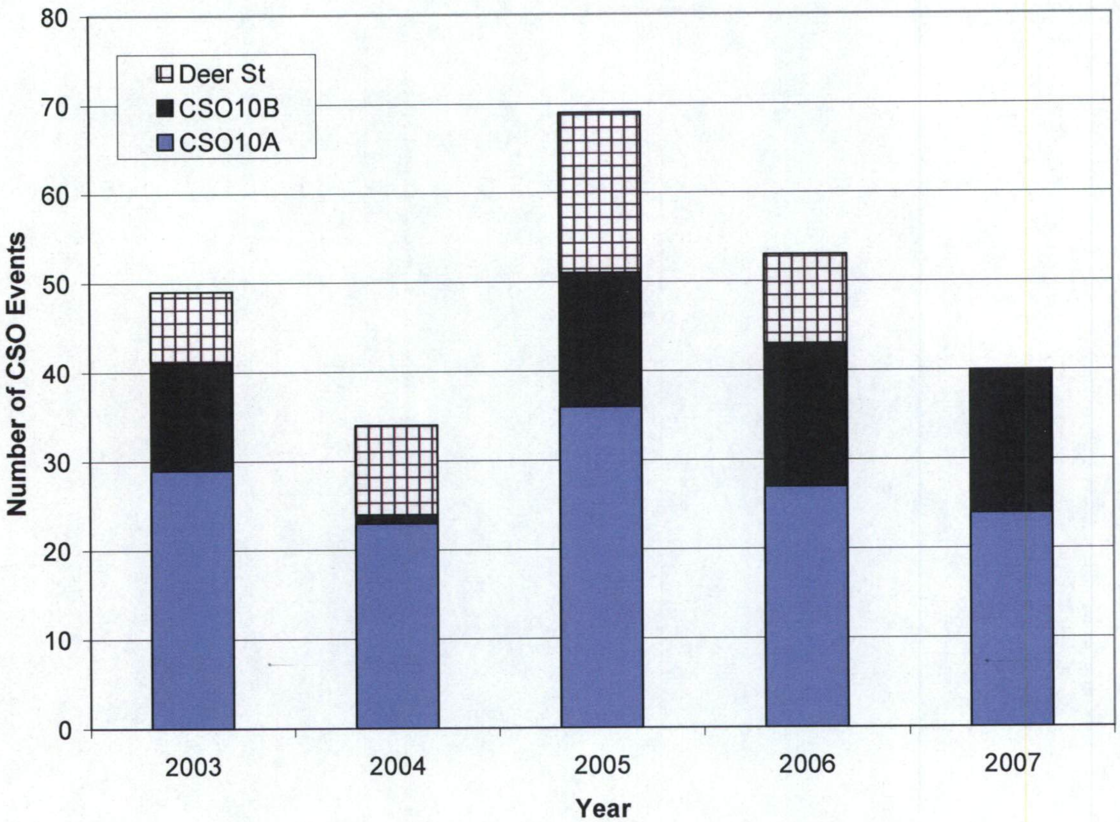


CSOs

During wet weather, the volume of combined sanitary sewage and storm water flows can exceed the capacity of the collection system, resulting in surcharging, flooding, and CSOs. The flows presented so far do not include flows discharged through the CSOs. This section presents historical data related to the frequency of CSO activation and volumetric discharge.

The City of Portsmouth has three permitted CSOs: CSO 10A, CSO 10B, and Deer Street. Figure 3.7 presents the number of CSO activations for the years 2003 through 2007. Figures 3.8 and 3.9 present the annual CSO volume and rainfall for the same period, respectively. CSO data for Deer Street was not available from August 2006 through May 2007 due to monitoring equipment failure.

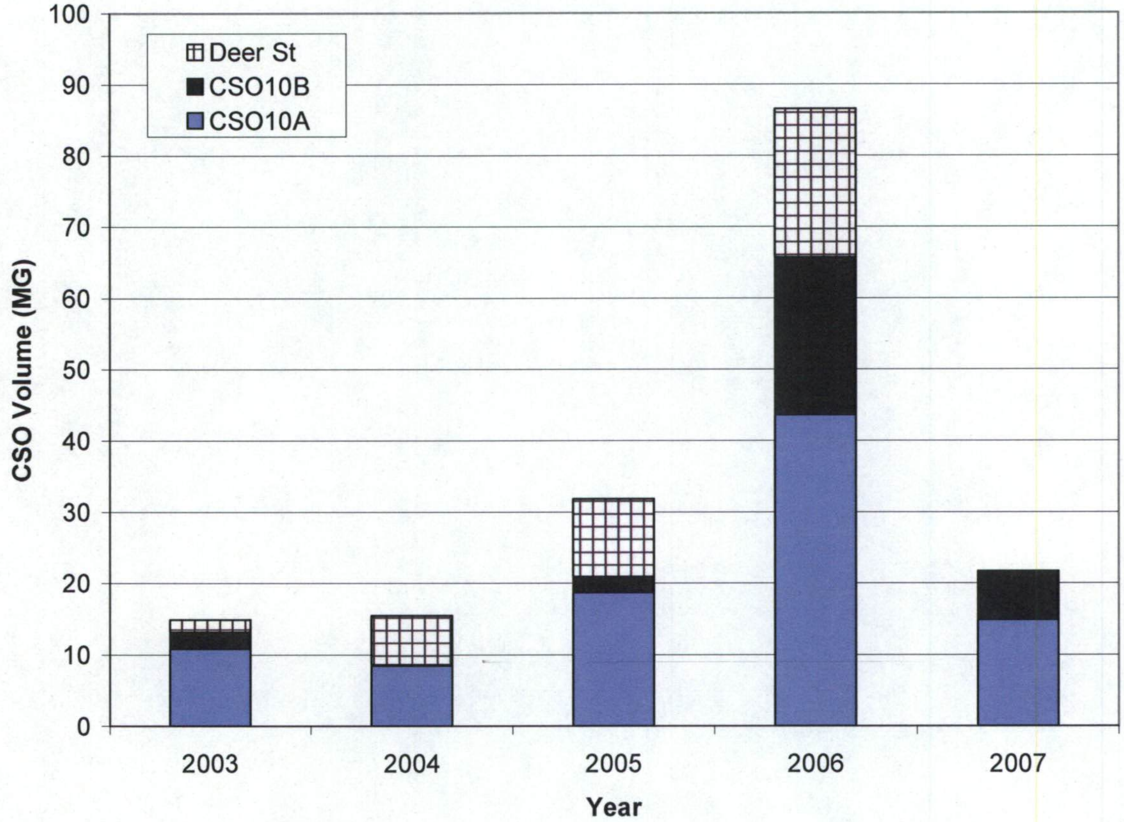
Figure 3.7 Annual CSO Activations 2003-2007 (1)



Notes:

1. Measurements are not available at Deer Street for the period from August 2006 through May 2007 due to monitoring equipment failure.

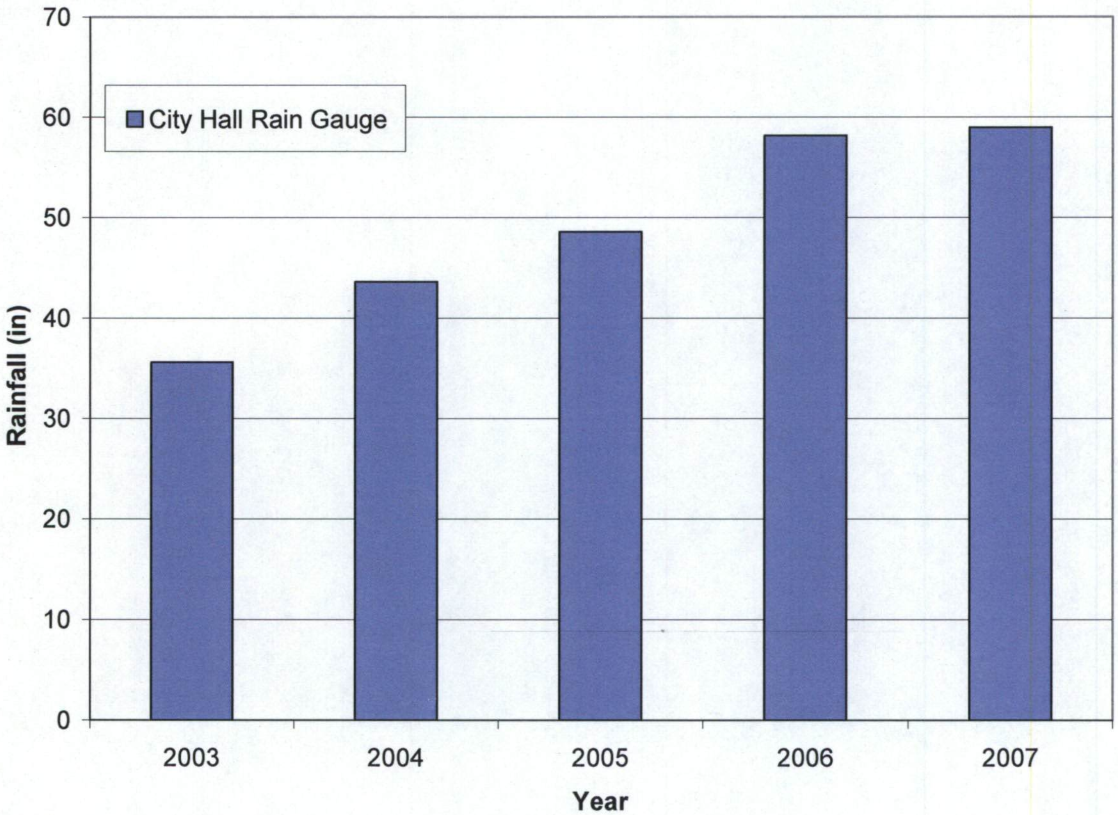
Figure 3.8 Annual CSO Volumes 2003-2007 (1)



Notes:

1. Measurements are not available at Deer Street for the period from August 2006 through May 2007 due to monitoring equipment failure.

Figure 3.9 Annual Rainfall 2003-2007
(Source: City Hall Rain Gauge)



3.3.1.2.Influent Loads

This section presents the historic BOD, TSS, and total Nitrogen influent loadings to the WWTFs. The BOD and TSS loadings are monitored regularly and will be presented first. Nitrogen loadings are measured occasionally and will be discussed afterwards.

Peirce Island Wastewater Treatment Facility

Historic influent BOD and TSS records were collected from Monthly Discharge Reports at the Peirce Island WWTF. The average annual influent loadings are shown in Figure 3.10 and Table 3.4. While there is variation from year to year, there does not seem to be a trend of either increasing or decreasing loads.

Figure 3.10 Average Annual Influent Loading Rate at the Peirce Island Wastewater Treatment Facility

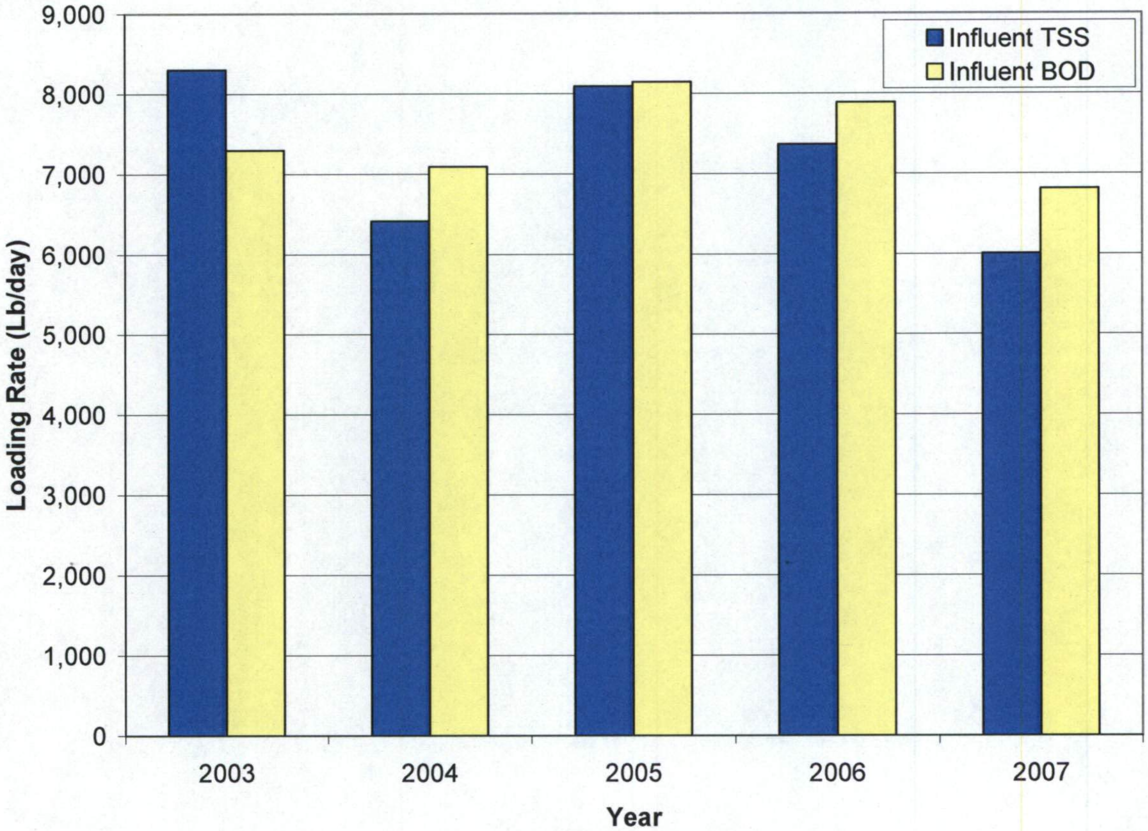


Table 3.4 Average Annual Influent Loading Rates at the Peirce Island Wastewater Treatment Facility

Year	Load (Lb/d)	
	BOD	TSS
2003	7,295	8,304
2004	7,090	6,416
2005	8,144	8,090
2006	7,887	7,368
2007	6,812	6,004

The estimated contribution of influent loadings to the Peirce Island WWTF by Portsmouth, Rye, Greenland, and New Castle are shown in Table 3.5. The influent loadings were distributed proportionally to the different sources based flow. As shown in the Table, Portsmouth is the overwhelming contributor of TSS and BOD to the Peirce Island WWTF.

Table 3.5 Average Annual Influent Loading Rates at the Peirce Island Wastewater Treatment Facility by Source

Source	Average Annual Loading Rate (lb/day)	
	BOD	TSS
Portsmouth	6,606 (1)	5,822 (1)
Rye	18 (1)	16 (1)
Greenland	24 (1)	21 (1)
New Castle	164 (1)	144 (1)
Total	6,812 (2)	6,004 (2)

Notes:

1. Estimated by multiplying total load at the WWTF by the percentage of sanitary flow contributed by the entity.
2. Total loads to the Peirce Island WWTF. Values developed from data measured from 1994 - 2007. Does not include loads discharged from the permitted CSOs.

The discharge of nitrogen is not regulated at the Peirce Island WWTF. However, the City intermittently sampled influent nitrogen levels in 2008, collecting data to develop a baseline for future considerations, since nitrogen may be regulated in a future NPDES permit. Influent nitrogen data has been collected by grab sample at the Peirce Island with total nitrogen values ranging from 5 mg/l to 54 mg/l. Due to the limited number of samples that have been collected, sufficient data is not available to perform a statistically significant analysis.

Given the limited industry tributary to the Peirce Island WWTF, and based on data collected to date, the maximum total nitrogen of 54 mg/l at a flow of 6.7 mgd, which occurred on January 15, 2008 will be utilized. This equates to a mass load of approximately 3,000 lbs/d of total nitrogen.

Pease Wastewater Treatment Facility

Historic influent BOD and TSS records were collected from Monthly Discharge Reports at the Pease WWTF. The average annual influent loadings are shown in Figure 3.11 and Table 3.6. As mentioned previously, changes in industrial customer base have taken place since 2004. Figure 3.11 suggests that these changes have may have resulted in an increase in loadings, particularly BOD.

Figure 3.11 Average Annual Influent Loading Rate at the Pease Wastewater Treatment Facility

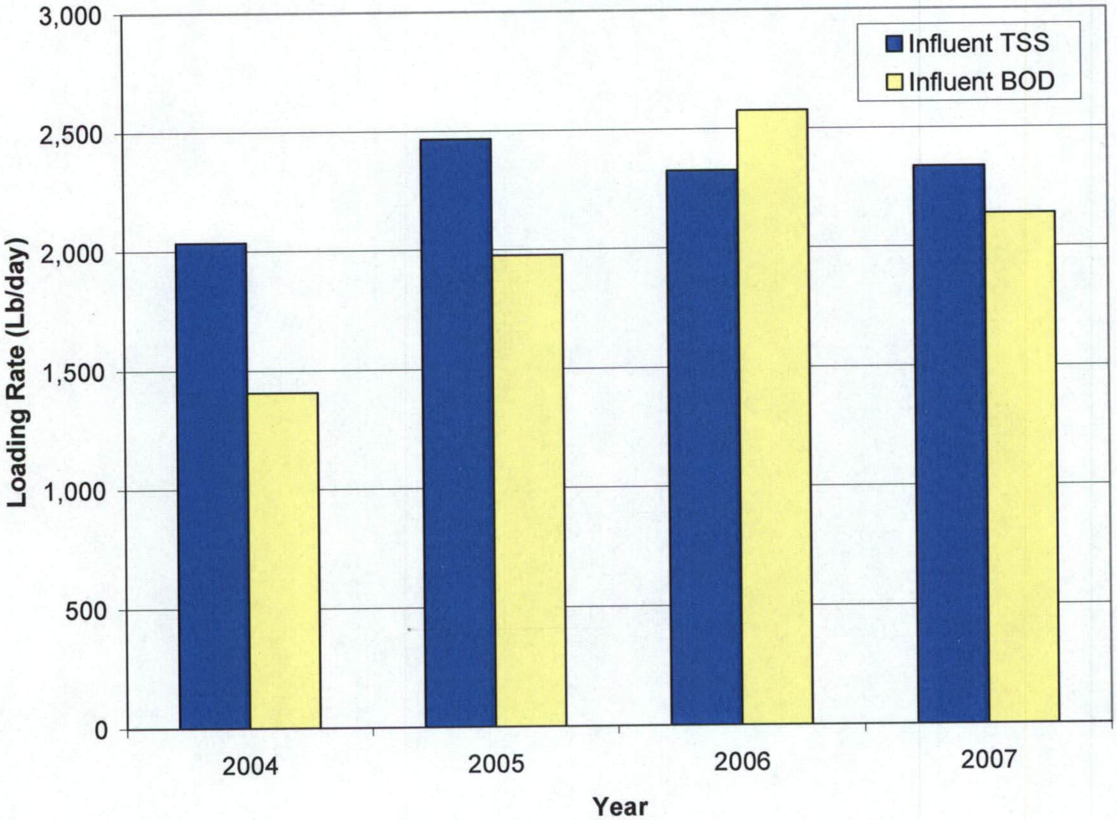


Table 3.6 Average Annual Influent Loading Rates at the Pease Wastewater Treatment Facility

Year	Load (Lb/d)	
	BOD	TSS
2004	1,406	2,035
2005	1,977	2,466
2006	2,577	2,325
2007	2,137	2,337

Historical influent nitrogen data for the Pease WWTF was limited due to changes in influent nitrogen sampling and analysis procedures at the WWTF. In 2005, influent wastewater was analyzed for total Kjeldahl nitrogen (TKN), which determines the combined concentration of organic nitrogen and ammonia. However, since December 2007 influent samples have been analyzed for a modified total nitrogen concentration that includes ammonia, nitrate, and nitrite, but not organic nitrogen compounds. These data represent essentially the total inorganic nitrogen concentration entering the WWTF. Based on these data, the following ranges were determined:

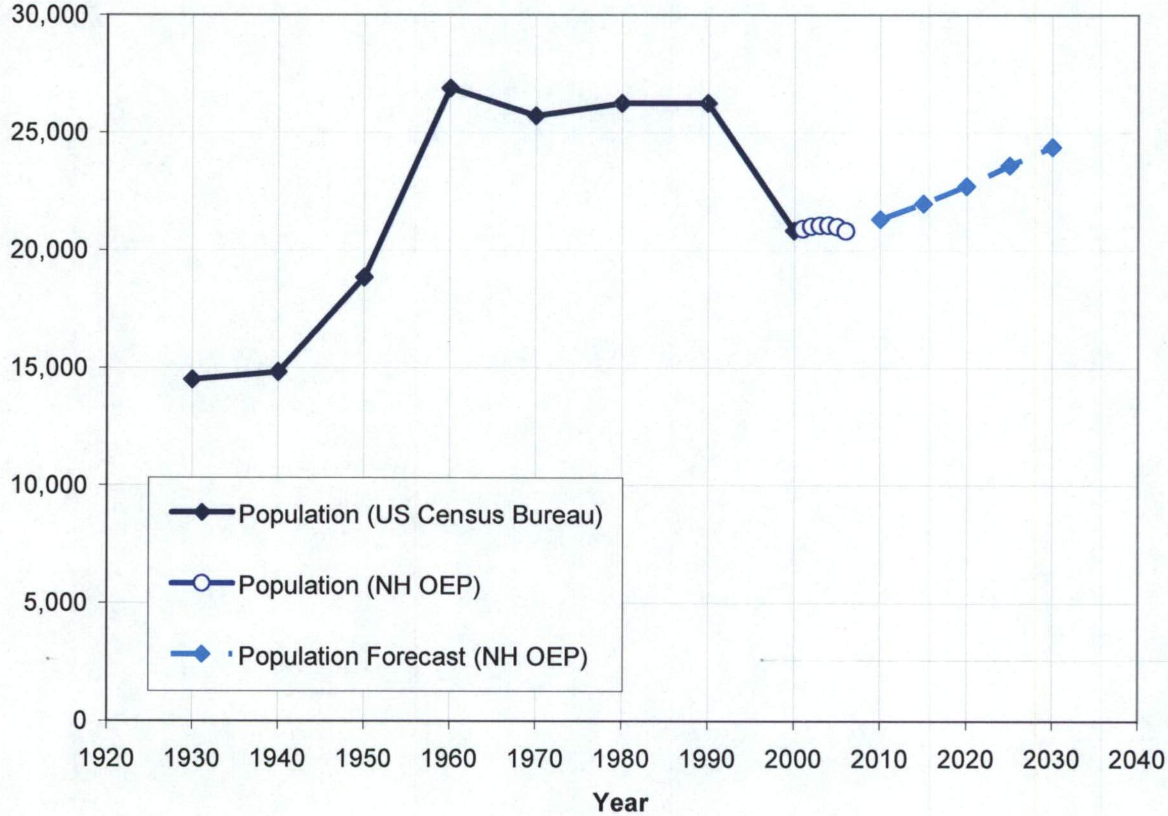
- Influent concentrations
    - TKN (organic N, ammonia): 10 to 71 mg/L
    - Total inorganic nitrogen (ammonia, nitrate, nitrite): 21 to 76 mg/L
- Influent loading
    - TKN: 89 to 379 lbs/day
    - Total inorganic nitrogen: 148 to 457 lbs/day

It is assumed that the highest measured total inorganic nitrogen measured (457 lb/days) is a reasonable estimated of the total average daily nitrogen loading. Although a conservative approach, it is assumed that using this maximum value will yield an overestimate that may account for the organic nitrogen load that would be included in an average of actual total nitrogen loading to the WWTF. These data and the assumptions will be revisited once additional nitrogen data is collected at the WWTF.

3.4. Population and Employment Forecasts

Population and employment forecasts provide the basis for developing the wastewater flow and load forecasts. Population forecasts were provided by the New Hampshire Office of Energy and Planning (NH OEP). The forecasts extend to the year 2030. The forecasts are shown in Figure 3.12 along with historic population data. The population peaked at 26,900 in 1960 and remained above a level of 25,000 people until the 1990s. The decline in the 1990s is due to the closing of the Pease Air Force Base. The population data from the NH OEP indicates that the population has remained fairly steady since 2000.

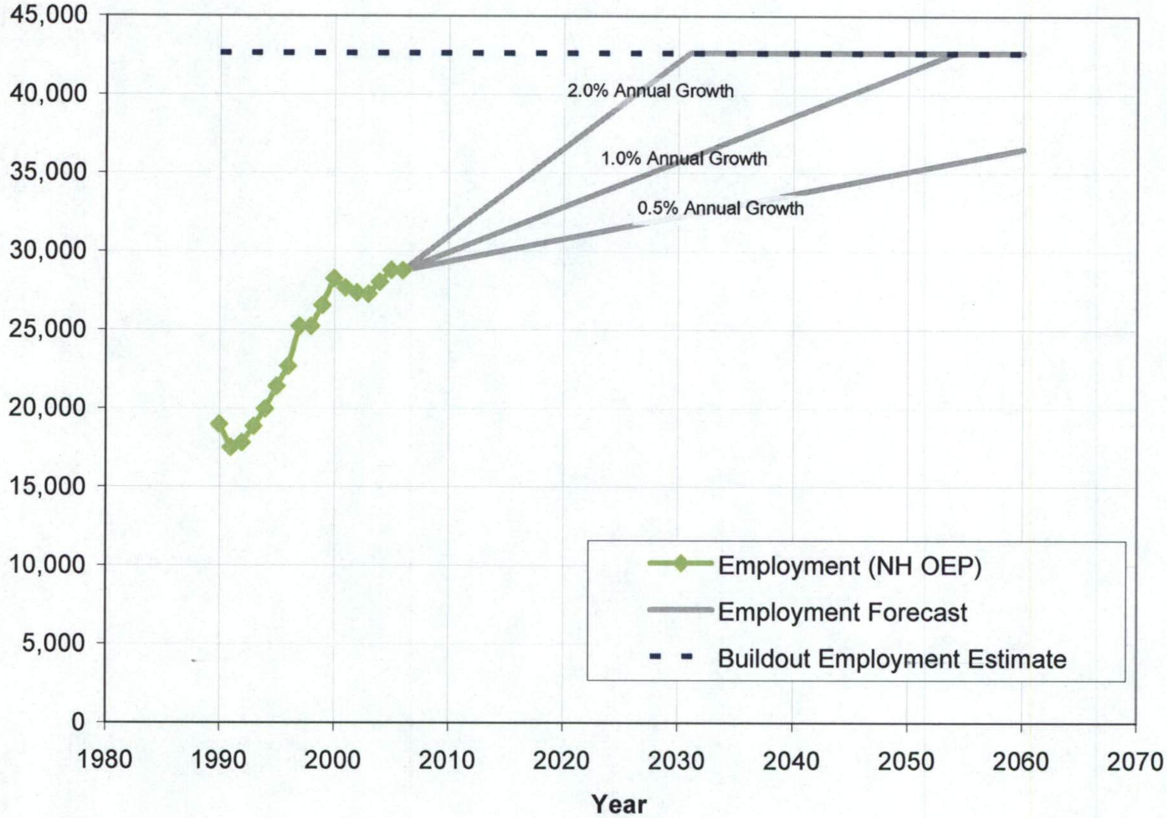
Figure 3.12 City of Portsmouth Historical and Forecasted Population



Employment forecasts for the City of Portsmouth were not available from NH OEP or any other planning agencies. There is a significant potential for growth in employment in Portsmouth (see Section 3.5). As a result, the employment forecast could have a strong impact on the wastewater flow and load forecasts.

With no forecasts available from planning agencies, low, medium, and high employment growth forecasts were developed. Under the low growth scenario, employment grows at 0.5 percent annually. The employment grows at 1.0 percent and 2.0 percent annually under the medium and high growth scenarios, respectively. The forecasts along with historic employment data are shown in Figure 3.13.

Figure 3.13 City of Portsmouth Historical and Forecasted Employment



The population and employment in the years 2000, 2006 and in the forecast years is shown in Table 3.7.

Table 3.7 City of Portsmouth Historic and Forecasted Population and Employment

Demographic	Year 2000		2006		2010		2020		2030		2040		2050		2060	
Population	20,825	(1)	20,811	(2)	21,320	(2)	22,730	(2)	24,390	(2)	25,881	(3)	27,373	(3)	27,450	(3)
Employment	28,258	(2)	28,768	(2)	29,343	(4)	30,782	(4)	32,220	(4)	33,659	(4)	35,097	(4)	36,535	(4)
					29,919	(5)	32,796	(5)	35,672	(5)	38,549	(5)	41,426	(5)	44,239	(5)
					31,069	(6)	36,823	(6)	42,577	(6)	42,653	(6)	44,239	(6)	44,239	(6)

Notes:

1. Source: United States Census Bureau
2. Source: New Hampshire Office of Energy and Planning
3. Assumes the average growth rate of the New Hampshire Office of Energy and Planning forecasts continues beyond 2030 until reaching the buildout population of 27,450 (see Section 3.5) in the year 2051.
4. Low growth employment forecast: 0.5% annual growth rate.
5. Medium growth employment forecast: 1.0% annual growth rate. Employment reaches buildout level of 44,239 in the year 2054.
6. High growth employment forecast: 2.0% annual growth rate. Employment reaches buildout level of 44,239 in the year 2031.

3.4.1. Buildout Population and Employment Forecasts

The buildout analysis estimated the maximum allowable density of development in the City. As noted earlier, the Capacity Assurance Planning Environment (CAPE) model was used to perform the analysis.

3.4.1.1. Undevelopable/Developable Area

The buildout analysis assumes that there are portions of the City in which future growth is restricted. For convenience, these areas are referred to as undevelopable areas even though there may already be some existing development. The undevelopable areas are defined as follows:

- Areas within 100 feet of freshwater bodies
- Areas within 50 feet of high tide mark north of Little Harbor
- Areas within 100 feet of high tide mark south of Little Harbor
- Conservation lands
- Cemeteries

+ historic sites? archaelogicil sites..

The undevelopable area within the City of Portsmouth is shown in Figure 3.14.

3.4.1.2. Buildout Population

For areas zoned residential, the buildout population is estimated by performing the following steps for each parcel:

1. Determine the maximum number of lots that a parcel can be subdivided into
2. Multiply the number of lots by the number of people per household at buildout

The maximum number of lots that a parcel can be subdivided into is determined by the parcel's developable area and the minimum lot size required by zoning regulations. Table 3.8 shows the minimum lot size for each of the residential zoning districts.

Table 3.8 Minimum Lot Size for Residential Zoning Districts

Zoning	Description	Minimum Lot Size (square feet)
SRA	Single Residence A	43,560
SRB	Single Residence B	15,000
GRA	General Residence A	7,500
GRB	General Residence B	5,000
GA/MH	Garden Apartment/Mobile Home	10,000
A	Apartment	3,500
R	Rural Residential	217,800
MRO	Mixed Residential Office	7,500
MRB	Mixed Residential Business	7,500

Source: City of Portsmouth Zoning Ordinance (December 1995)

It was assumed that the number of people per household at buildout is 2.4 across all of the zoning districts. This value is considered conservative as it is higher than the average household size of 2.04 people per household in the year 2000.

In cases where the existing population in a parcel is greater than the calculated buildout population, the buildout population was reset to the existing population.

The estimated buildout population is 27,450[2]. If population growth proceeds at the rate consistent with the NH OEP forecasts, the buildout population will be reached in 2051.

The estimated buildout population by zoning district is shown in Table 3.9. With a limitation of areas for available residential growth and the desirability of living in the downtown area, it is assumed that residential development of areas zoned CBA and CBB will be allowed in the future.

Table 3.9 Estimated Buildout Population by Residential Zoning District

Zoning District	Description	Area (acres)	Developable Area (acres)	Buildout Population
A	Apartment	38	37	1,687
GA/MH	Garden Apartment/Mobile Home	250	106	1,601
CBA	Central Business District A	19	9	587
CBB	Central Business District B	55	52	3,216
GRA	General Residence A	267	240	4,995
GRB	General Residence B	70	58	2,064
MRB	Mixed Residential Business	31	30	420
MRO	Mixed Residential Office	60	55	1,473
R	Rural Residential	604	105	122
SRA	Single Residence A	963	305	1,619
SRB	Single Residence B	1,366	883	9,668
Total		3,723	1,881	27,450

3.4.1.3.Buildout Employment

For area zoned commercial/institutional/industrial, the buildout employment is estimated by performing the following steps for each parcel:

1. Calculate the amount of building floor space by multiplying the floor area ratio (FAR) by the developable area of the parcel
2. Multiply the amount of building floor space by the building floor area per employee (FER) ratio

[2] The estimated buildout population of the 201 Facilities Plan Update (Underwood Engineers, Inc., November 1999) was 26,330. The difference is likely due to changes in zoning and the assumption by this Study that residential development will be allowed in the CBA and CBB zoning districts.

Table 3.10 shows the FAR ratios for each of the commercial/ institutional/ industrial zoning districts. The maximum allowable FARs were determined from the City's Zoning Ordinance. Current FARs were calculated using available GIS data.

During the development of the employment buildout forecast, it was determined that using the maximum FARs allowable under the current zoning ordinance resulted in an estimated buildout employment in excess of 600,000. This estimate was clearly too high. In order to arrive at a more realistic estimate, a growth factor was applied to the existing FARs[3]. The growth factors were developed through discussions with City staff about where increased density of development is likely to occur. The FARs used in the buildout analysis are shown in Table 3.10.

It was assumed that the FER will be 500 square feet per employee at buildout for all of the zoning districts.

Table 3.10 Floor to Parcel Area Ratios for Commercial/Industrial/Institutional Zoning

Zoning District	Description	Maximum FAR (1)	Current FAR (2)	Assumed FAR at Buildout (3)
ABC	Airport Business Commercial	4.8	0.08	0.13 (4)
AI	Airport Industrial	4	0.08	0.17 (4)
AIR	Airport	1	0	0.01 (4)
B	Business	1.8	0.32	0.40
CBA	Central Business A	3.5	0.5	0.75
CBB	Central Business B	5.7	1.28	1.50
GB	General Business	2.1	0.08	0.10
I	Industrial	3.5	0.06	0.08
M	Municipal	NA	0.04	NA
MRB	Mixed Residential Business	1.6	0.2	0.30
MRO	Mixed Residential Office	1.6	0.36	0.40
NRP	Natural Resource Protection	NA	0	NA
OR	Office Research	1.8	0.13	0.15
OR/MV	Office Research/Marine's Village	1.8	0.04	0.15
PI	Pease Industrial	2.4	0.12	0.17 (4)
WB	Waterfront Business	0.9	0.06	0.08
WI	Waterfront Industrial	3.5	0.1	0.15

Notes:

1. City of Portsmouth Zoning Ordinance (December 1995)
2. Values developed from GIS analysis using existing zoning boundaries, parcel areas, and building floor areas
3. Unless otherwise noted, values were estimated by applying a growth factor to FARs. The growth factor was estimated based on discussions with City staff about what areas are likely to experience high density development.
4. Developed from a buildout analysis performed by Underwood Engineers, Inc. of the Pease Development Authority.

[3] The assumed FARs at buildout for zoning districts in the Pease Development Authority were calculated differently. They were based on values developed by Underwood Engineers for a buildout analysis of the Pease Development Authority.

Currently, there is an estimated 1.4 employees per resident in Portsmouth. At buildout, this ratio is estimated to be 1.6 employees per resident. For comparison purposes, a survey of 164 communities under existing conditions in the greater Boston area found that only three communities had employee to resident ratios of 1.4 or greater. The communities included Bedford, Burlington, and Avon with ratios of 1.7, 1.6, and 1.4 employees per resident, respectively.

Table 3.11 Estimated Buildout Employment by Zoning District

Zoning District	Description	Area (acres)	Developable Area (acres)	Buildout Employment
ABC	Airport Business Commercial	654	474	6,386
AI	Airport Industrial	103	77	1,464
AIR	Airport	1,572	1,287	1,198
B	Business	59	56	2,402
CBA	Central Business A	19	9	635
CBB	Central Business B	55	52	4,805
GB	General Business	709	453	7,104
I	Industrial	840	400	5,428
M	Municipal	624	45	2,037
MRB	Mixed Residential Business	31	30	497
MRO	Mixed Residential Office	60	55	1,408
NRP	Natural Resource Protection	1,084	33	132
OR	Office Research	285	158	4,336
OR/MV	Office Research/Marine's Village	107	88	1,293
PI	Pease Industrial	183	121	2,680
WB	Waterfront Business	29	10	197
WI	Waterfront Industrial	180	107	2,238
	Total	6,594	3,456	44,239

The year in which buildout employment would be reached for the three different employment growth scenarios is shown in Table 3.12.

Table 3.12 Estimate of Employment Buildout Year

Scenario	Growth Rate	Buildout Employment Year
Low	0.5%	2102
Medium	1.0%	2054
High	2.0%	2031

3.5. Sewered Area

The type of wastewater service currently employed in parcels throughout the City of Portsmouth is shown in Figure 3.15. The type of wastewater service was estimated by proximity to sewer. Parcels with no development were considered to have no wastewater service. Table 3.13 presents a summary of sewer service throughout the City. As can be seen from Figure 3.15 and Table 3.13, most of the City of Portsmouth is currently sewered.

Table 3.13 Wastewater Service in City of Portsmouth

Wastewater Service	Parcels		Area (acres)	
Sewered	5,794	(92%)	6,434	(63%)
On-Site	355	(6%)	748	(7%)
None	166	(3%)	2,969	(29%)
Total	6,315	(100%)	10,151	(100%)

3.6. Development of Wastewater Generation Rates

The development of wastewater flow and loading rates is discussed in this section. These rates will be used along with the demographic forecasts in Section 3.4 to develop wastewater flow and loading forecasts for the WMP.

3.6.1.1. Wastewater Flows for Current Conditions

The sections which follow discuss the calibration of the wastewater unit flow rates for the residential population and commercial/institutional/industrial development. Different types of commercial/institutional/industrial development produce different amounts of flow. For example, a retail shopping complex may produce less wastewater than an industrial factory per square foot of building floor space. Likewise, there is variability in flow generation rates in residential development. For example, per capita wastewater generation may be lower in apartments than single-family housing. In order to account for variability in wastewater generation rates for different development types, wastewater generation rates were developed for the different existing use types shown in Table 3.14.

Table 3.14 Existing Use Types

Residential Use	
1F	Single family
2F	Two family
3F	Three family
MF	Apartment
MH	Mobile Home
Commercial Use	
HOTEL	Inn/Hotel
STORE	Store
REST	Restaurant
AUTO	Automotive
WASH	Carwash
COM-OTH	Other
GYM	Gym
OFFICE	Office
Institutional Use	
HOSP	Hospital
SCH	School
CF	Care facility
MUNI	Municipal
INT-OTH	Other
Mixed Use	
MIXED	Mixed Use
Other Use	
UNDEV	Undeveloped
CEM	Cemetery
OUT	Outbuilding

Water Usage Records

Water use records were matched with their respective parcels and unit flow generation rates were calculated. Since outdoor water usage is at a minimum during the winter and spring, the analysis of water use records was performed from the period of time from January 2007 through May 2007.

Approximately 5,000 of the 8,000 water accounts and 43,000 out 70,000 water meter readings were matched with parcels in Portsmouth. A sizable portion of the unmatched accounts and water meter readings are for water usage outside of Portsmouth.

The average daily water usage for all of the water accounts from January 2007 through May 2007 was 2.78 MGD. The average daily water usage in the Portsmouth parcels that were matched with water accounts was 1.36 MGD, approximately half of the total.

Water Usage by Residential Development

Residential water usage in parcels with matched water accounts is shown in Table 3.15. The water usage in these parcels totaled 0.70 MGD. If the per capita flow rates in Table 3.15 are extrapolated to the rest of the sewered population in Portsmouth, the total water usage is estimated to be 0.88 MGD.

Table 3.15 Residential Water Usage in Parcels with Matched Water Accounts (January – May 2007)

Existing Use		Parcels with Matched Water Accounts			
Code	Description	Count	Population	Average Daily Water Usage (gpd)	Per capita flow rate (gpcd)
1F	Single family	3,472	11,123	432,946	39
2F	Two family	353	1,498	62,233	42
3F	Three family	74	404	19,061	47
MF	Apartment	144	2,552	126,324	49
MIXED	Mixed Use	304	1,480	61,558	42

The water usage rates range as shown in Table 3.15 vary from 39 to 49 gallons per capita per day. Typical municipal water use varies from 40-130 daily per capita consumption (gpcd) in the United States with an average rate of 60 gpcd (Metcalf and Eddy, 1991).

Water Usage by Commercial/Institutional/Industrial Development

Commercial/institutional/industrial water use in parcels with matched water accounts is shown in Table 3.16. The water use in these parcels totaled 0.66 MGD. If the per building area flow rates in Table 3.16 are extrapolated to the rest of the sewered commercial/industrial/institutional development in Portsmouth, the total water usage is estimated to be 0.93 MGD.

Table 3.16 Commercial/Industrial/Institutional Water Usage in Parcels with Matched Water Accounts (January – Mary 2007)

Existing Use		Parcels with Matched Water Accounts			
Code	Description	Count	Building Floor Area (sq ft)	Average Daily Water Usage (gpd)	Per Building Area Flow Rate (gpsfd)
HOTEL	Inn/Hotel	14	969,936	21,656	0.022
STORE	Store	77	2,229,187	62,477	0.028
REST	Restaurant	31	275,872	30,648	0.111
AUTO	Automotive	47	556,797	18,451	0.033
WASH	Carwash	3	10,266	14,148	1.378
COM-OTH	Other	4	72,999	1,028	0.014
GYM	Gym	1	32,985	192	0.006
OFFICE	Office	109	2,556,223	49,729	0.019
HOSP	Hospital	1	755,490	21,639	0.029
SCH	School	7	657,441	1,573	0.002
CF	Care facility	3	76,935	16,996	0.221
MUNI	Municipal	18	956,187	4,655	0.005
INT-OTH	Other	53	698,234	14,963	0.021
MIXED	Mixed Use	304	1,803,427	153,895	0.085
IND-GEN	General industrial	77	5,175,622	302,742	0.058
UNDEV	Undeveloped	5	225,050	1,958	0.009
CEM	Cemetery	0	NA	NA	NA
OUT	Outbuilding	3	66,344	462	0.007

3.6.1.2.Sanitary Flow

As shown in Table 3.3, the City of Portsmouth contributes 2.53 MGD of sanitary flow to the Peirce Island WWTF and 0.41 MGD of sanitary flow to the Pease WWTF. However, the total estimated water usage in the sewered portions of the City is only 1.81 MGD (0.88 MGD for residential areas and 0.93 MGD from commercial/institutional/industrial areas). The reason for discrepancy is unknown. However, the low per capita wastewater generation rates support the conclusion that water usage is being under measured.

The sanitary flow generation rates for each of the existing uses were calibrated until they matched the expected flow rates at the WWTFs attributable to the City. The resulting wastewater generation rates for the existing use types are shown in Tables 3.17 and 3.18 for the residential and commercial/industrial/institutional existing uses, respectively. The wastewater generation rates seem to be within a reasonable range.

Table 3.17 Calibrated Wastewater Generation Rates for Residential Existing Uses

Existing Use		Per capita flow rate (gpcd)
Code	Description	
1F	Single family	72
2F	Two family	68
3F	Three family	68
MF	Apartment	65
MH	Mobile Home	65
MIXED	Mixed Use	68

Table 3.18 Calibrated Wastewater Generation Rates for Existing Commercial/Industrial/Institutional Uses

Existing Use		Per building area flow rate (gpsfd)
Code	Description	
HOTEL	Inn/Hotel	0.07
STORE	Store	0.06
REST	Restaurant	0.24
AUTO	Automotive	0.08
WASH	Carwash	2.62
COM-OTH	Other	0.03
GYM	Gym	0.04
OFFICE	Office	0.05
HOSP	Hospital	0.05
SCH	School	0.02
CF	Care facility	0.42
MUNI	Municipal	0.02
INT-OTH	Other	0.05
MIXED	Mixed Use	0.20
IND-GEN	General industrial	0.15
UNDEV	Undeveloped	0.00
CEM	Cemetery	0.00
OUT	Outbuilding	0.04

3.6.1.3.I/I

In accordance with Phase I of its 2005 Long Term Control Plan, the City of Portsmouth has on ongoing program to separate targeted combined sewers. When completed, it is expected that this program will reduce the amount of extraneous flows entering the City's collection system, reduce CSO activity, and some level of I/I. However, it is also recognized that the system will continue to age and deteriorate with time, and that this will lead to more I/I entering the system. As a result, it is assumed that these two effects will balance the other so that rates of I/I could actually remain relatively unchanged during the planning horizon.

IS THIS PROPER O&M OF THE COLLECTION SYSTEM?

3.6.2. Wastewater Unit Flow Rates for Future Conditions

The CAPE model transitions development in the parcels from the existing land use type to the zoning land over a period of 20 years. The wastewater unit flow rates for the existing types were discussed in the previous section. This section presents the wastewater unit flow rates for the zoned land use types.

The wastewater unit flow rates for the zoning districts were based on an analysis of the wastewater unit flow rates for existing uses. The wastewater unit flow rates for residential zoning districts are shown in Table 3.19. The wastewater unit flow rates for commercial/industrial/ institutional zoning districts are shown in Table 3.20.

Table 3.19 Residential Wastewater Generation Rates for Zoning Districts

Zoning District		Loading Rate (gpcd)
Code	Description	
A	Apartment	70
GA/MH	Garden Apartment/Mobile Home	70
GRA	General Residence A	75
GRB	General Residence B	75
MRB	Mixed Residential Business	70
MRO	Mixed Residential Office	70
R	Rural Residential	85
SRA	Single Residence A	85
SRB	Single Residence B	85

Source: Values were estimated based on an analysis of wastewater generation rates for similar existing uses (see Table 3.17)

Table 3.20 Commercial/Industrial/Institutional Wastewater Generation Rates for Zoning Districts

Zoning District		Loading Rate (gpsfd)
Code	Description	
ABC	Airport Business Commercial	0.05
AI	Airport Industrial	0.08
AIR	Airport	0.05
B	Business	0.05
CBA	Central Business A	0.15
CBB	Central Business B	0.15
GB	General Business	0.05
I	Industrial	0.15
M	Municipal	0.01
MRB	Mixed Residential Business	0.2
MRO	Mixed Residential Office	0.2
NRP	Natural Resource Protection	0.02
OR	Office Research	0.05
OR/MV	Office Research/Marine's Village	0.04
PI	Pease Industrial	0.1
WB	Waterfront Business	0.1
WI	Waterfront Industrial	0.05

Source: Values were estimated based on an analysis of wastewater generation rates for similar existing uses (see Table 3.18)

3.6.3. Unit Loading Rates

Historical BOD, TSS, and Total Nitrogen loadings were discussed in Section 3.3.1. BOD and TSS loadings have remained fairly level at the Peirce Island WWTF. It is assumed that the average of BOD and TSS loadings from 2003 through 2007 represent average conditions. Loading rates at Pease have varied in the recent past due to changes in industries within the Pease Development Authority. It is assumed, however, that the last two years reflect average conditions. Limited total Nitrogen data was available at the two WWTFs. Due the limited availability of data, it was difficult to estimate currently loadings. In order to be conservative, it is assumed that total Nitrogen loadings are roughly equivalent to the highest measurements taken. The assumed average annual loadings at the two WWTFs under current conditions are shown in Table 3.21.

Table 3.21 Estimated Average Annual Loadings for Current Conditions

	BOD (lb/day)	TSS (lb/day)	Total Nitrogen (lb/day)
Peirce Island WWTF			
Portsmouth	7,220	7,018	2,910
Others	225	219	90
Total	7,446	7,236	3,000
Pease WWTF	2,357	2,331	457

BOD, TSS, and total Nitrogen unit loading rates were developed and are shown in Table 3.22.

BOD and TSS loading rates were assumed to be 0.2 pound per capita per day (lbpcd) for the residential population. These rates are typical values (Metcalf and Eddy, 1991). The BOD and TSS loading rates for commercial/institutional/industrial development were then calibrated to achieve the target system-wide values. Different loading rates were developed for commercial/institutional/industrial development tributary to the WWTFs. The BOD and TSS loading rates for commercial/institutional/industrial development were expressed in pounds per square feet of building floor space per day (lbsfd).

The total Nitrogen loading was assumed to be 0.03 lbpcd for the residential population. This value is towards the upper end of typical values for total Kjeldahl nitrogen (Metcalf and Eddy, 1991)[4]. The BOD and TSS loading rates for commercial/institutional/industrial development were then calibrated to achieve the target system-wide values.

Table 3.22 BOD, TSS, and Total Nitrogen Unit Loading Rates

Contributor	BOD	TSS	Total Nitrogen
Residential Population	0.20 lbpcd	0.20 lbpcd	0.03 lbpcd
Commercial/Institutional/Industrial Development			
Tributary to Peirce Island WWTF	0.0003 lbsfd	0.0002 lbsfd	0.00019 lbsfd
Tributary to Pease WWTF	0.0006 lbsfd	0.0006 lbsfd	0.00013 lbsfd

It is assumed that the loading rates shown in Table 3.22 will also apply to future growth in the study area.

[4] Typical range identified in Metcalf and Eddy (1991) is 0.020 – 0.031 for total Kjeldahl nitrogen. Total nitrogen loading rates were not identified in Metcalf and Eddy (1991).

3.7. Wastewater Flow and Load Forecasts

The information developed in the previous Sections was used to develop wastewater flow and load forecasts for the Peirce Island and Pease WWTFs. In developing the forecasts, it was assumed that the entire City of Portsmouth will be sewered between the years 2010 and 2020 (see Section 3.5 for a discussion of current sewering conditions).

The forecasted sanitary flows for the Peirce Island WWTF are shown in Table 3.23. Flows from each of the contributing communities are shown. The Portsmouth flows are presented for the three different employment growth scenarios (each of these scenarios also includes the NH OEP forecasted population). The difference in the sanitary flows in the year 2060 at the Peirce Island WWTP between the low and high employment growth scenarios is approximately 200,000 gpd.

The flow forecasts for New Castle and Rye are based on the assumption of full utilization of the flow entitlements by the year 2030. The flow forecasts for Greenland are based on full utilization of available sewer service capacity by the year 2030.

Table 3.23 Forecasted Sanitary Flows for the Peirce Island WWTF

Source	Sanitary Flow (gpd)					
	2010	2020	2030	2040	2050	2060
Portsmouth						
Low employment growth (0.5%)	2,552,171	2,853,152	3,034,826	3,153,561	3,272,295	3,298,614
Medium employment growth (1.0%)	2,560,366	2,896,858	3,112,151	3,264,506	3,416,860	3,476,799
High employment growth (2.0%)	2,571,179	2,961,559	3,226,624	3,369,085	3,471,769	3,482,037
Other Communities						
Greenland (1)	16,783	37,267	62,000	62,000	62,000	62,000
New Castle (2)	82,174	126,492	180,000	180,000	180,000	180,000
Rye (3)	24,783	82,391	140,000	140,000	140,000	140,000
Total						
Low employment growth (0.5%)	2,675,910	3,099,303	3,416,826	3,535,561	3,654,295	3,680,614
Medium employment growth (1.0%)	2,684,106	3,143,008	3,494,151	3,646,506	3,798,860	3,858,799
High employment growth (2.0%)	2,694,918	3,207,710	3,608,624	3,751,085	3,853,769	3,864,037

Notes:

1. Existing force main capacity.
2. Intermunicipal Agreement
3. Report prepared by CMA Engineers (October 1995).

The total forecasted wastewater flows for the Peirce Island WWTF are presented in Table 3.24. The flows shown in the table include sanitary flow and I/I. As mentioned in Section 3.6.1.3, the I/I is assumed to remain at the levels presented in Table 3.3 through the planning horizon.

Table 3.24 Forecasted Wastewater Flows for the Peirce Island WWTF

Condition	Total Wastewater Flow (MGD)					
	2010	2020	2030	2040	2050	2060
Average Annual						
Low employment growth (0.5%)	5.57	5.99	6.31	6.43	6.54	6.57
Medium employment growth (1.0%)	5.57	6.03	6.38	6.54	6.69	6.75
High employment growth (2.0%)	5.58	6.10	6.50	6.64	6.74	6.75
10-Year Maximum Average Annual						
Low employment growth (0.5%)	6.31	6.73	7.05	7.17	7.28	7.31
Medium employment growth (1.0%)	6.31	6.77	7.12	7.28	7.43	7.49
High employment growth (2.0%)	6.32	6.84	7.24	7.38	7.48	7.49
10-Year Maximum Month						
Low employment growth (0.5%)	8.95	9.37	9.69	9.81	9.92	9.95
Medium employment growth (1.0%)	8.95	9.41	9.76	9.92	10.07	10.13
High employment growth (2.0%)	8.96	9.48	9.88	10.02	10.12	10.13

The forecasted sanitary flows for the Pease WWTF are shown in Table 3.25. The wastewater forecasts for different I/I scenarios are presented in Table 3.26.

Table 3.25 Forecasted Sanitary Flows for the Pease WWTF

Employment Scenario	Sanitary Flow (gpd)					
	2010	2020	2030	2040	2050	2060
Low growth (0.5%)	447,943	581,306	714,208	847,288	980,368	1,114,599
Medium growth (1.0%)	470,198	677,744	884,830	1,092,093	1,299,357	1,507,771
High growth (2.0%)	531,739	944,374	1,356,559	1,520,737	1,519,458	1,519,331

Table 3.26 Forecasted Wastewater Flows for the Pease WWTF

Condition	Total Wastewater Flow (MGD)					
	2010	2020	2030	2040	2050	2060
Average Annual						
Low employment growth (0.5%)	0.68	0.81	0.94	1.08	1.21	1.34
Medium employment growth (1.0%)	0.70	0.91	1.11	1.32	1.53	1.74
High employment growth (2.0%)	0.76	1.17	1.59	1.75	1.75	1.75
10-Year Maximum Average Annual						
Low employment growth (0.5%)	0.79	0.92	1.05	1.19	1.32	1.45
Medium employment growth (1.0%)	0.81	1.02	1.22	1.43	1.64	1.85
High employment growth (2.0%)	0.87	1.28	1.70	1.86	1.86	1.86
10-Year Maximum Month						
Low employment growth (0.5%)	0.98	1.11	1.24	1.38	1.51	1.64
Medium employment growth (1.0%)	1.00	1.21	1.41	1.62	1.83	2.04
High employment growth (2.0%)	1.06	1.47	1.89	2.05	2.05	2.05

The influent BOD forecasts for the Peirce Island the Pease WWTFs are presented in Table 3.27 for the three different employment growth scenarios. The influent TSS forecasts for the two WWTFs are presented in Table 3.28. The influent Total Nitrogen forecasts for the two WWTFs are presented in Table 3.29.

Table 3.27 Forecasted BOD for the Peirce Island and Pease WWTFs

	Influent BOD (lb/d)					
	2010	2020	2030	2040	2050	2060
Low Employment Growth						
Peirce Island WWTF	7,491	7,986	8,679	9,366	9,693	9,758
Pease WWTF	2,340	2,488	2,634	2,781	2,928	3,074
Total	9,832	10,474	11,313	12,147	12,621	12,833
Medium Employment Growth						
Peirce Island WWTF	7,491	8,086	8,875	9,659	10,083	10,245
Pease WWTF	2,340	2,675	3,009	3,343	3,676	4,010
Total	9,832	10,761	11,883	13,001	13,759	14,255
High Employment Growth						
Peirce Island WWTF	7,491	8,298	9,224	9,982	10,274	10,303
Pease WWTF	2,340	3,246	3,942	4,220	4,220	4,220
Total	9,832	11,544	13,166	14,203	14,494	14,523

Table 3.28 Forecasted TSS for the Peirce Island and Pease WWTFs

	Influent TSS (lb/d)					
	2010	2020	2030	2040	2050	2060
Low Employment Growth						
Peirce Island WWTF	7,283	7,768	8,449	9,124	9,449	9,512
Pease WWTF	2,314	2,460	2,605	2,750	2,895	3,040
Total	9,597	10,228	11,054	11,874	12,344	12,552
Medium Employment Growth						
Peirce Island WWTF	7,283	7,860	8,632	9,397	9,812	9,966
Pease WWTF	2,314	2,645	2,975	3,305	3,635	3,965
Total	9,597	10,506	11,607	12,702	13,448	13,931
High Employment Growth						
Peirce Island WWTF	7,283	8,058	8,957	9,699	9,990	10,020
Pease WWTF	2,314	3,210	3,898	4,173	4,173	4,173
Total	9,597	11,268	12,855	13,872	14,164	14,193

Table 3.29 Forecasted Total Nitrogen for the Peirce Island and Pease WWTFs

	Influent Total Nitrogen (lb/d)					
	2010	2020	2030	2040	2050	2060
Low Employment Growth						
Peirce Island WWTF	3,035	3,357	3,595	3,785	3,856	3,728
Pease WWTF	454	483	512	540	569	597
Total	3,490	3,840	4,106	4,325	4,425	4,325
Medium Employment Growth						
Peirce Island WWTF	3,035	3,433	3,744	4,008	4,153	4,098
Pease WWTF	454	520	584	649	714	779
Total	3,490	3,952	4,329	4,657	4,867	4,877
High Employment Growth						
Peirce Island WWTF	3,035	3,595	4,010	4,255	4,299	4,142
Pease WWTF	454	630	766	820	820	820
Total	3,490	4,225	4,776	5,074	5,118	4,962

3.8. Sludge and Biosolids Forecasting

WWTFs produce various organic and chemical wastes that must be disposed of. Organic sludges are produced in primary clarifiers, at WWTFs so equipped. The sludges can be both organic and chemical in nature, if the WWTF utilized chemically enhanced primary treatment (CEPT), as employed at the Peirce Island WWTF. In general the chemical is usually a metal salt utilized enhance coagulation.

Biosolids are an organic byproduct of secondary treatment, and the rate of production is dependent on the treatment process employed. Lagoons have a very low biosolids yield, while high rate treatment processes have a relatively high yield. In general, lagoon systems do not waste sludge, and instead allow it to build in the settling lagoon. Activated sludge facilities usually waste biosolids on a daily basis.

Facilities which utilize tertiary treatment may also produce chemical sludges containing metal salts. Currently, only the Somersworth, NH WWTF utilizes tertiary treatment. However, it is likely that many of the WWTFs in the area may be producing tertiary sludges in the future, as discharge permit limits become more stringent.

3.8.1. Current Conditions

In addition to the Peirce Island and Pease WWTFs, there are 14 other WWTFs in the Study Area which, if a regional sludge and biosolids handing facility were constructed, might utilize it for disposal. In addition, four (4) local Maine communities might also utilize a regional facility, if it were available. Therefore, a total of 18 additional WWTFs may utilize a regional facility for sludge / biosolids disposal, if it were available.

Of the additional WWTFs included in this analysis, five (5) are either current or former lagoon systems. The sludge/biosolids production from these facilities are stored in lagoons, and these facilities were not been considered in this analysis. Typically, lagoon storage systems are desludged every 10 to 15 years, and while a regional facility may be identified as a disposal option, the impact would be short term. Therefore, sizing of the regional facility would not be based on the capacity required for the lagoon systems.

The breakdown of WWTFs which may contribute sludge and/or biosolids to a regional handling facility and its current production is summarized in Table 3.30.

All of the facilities listed dewater the sludge/biosolids prior to disposal, with dewatered sludge solids content ranging from a low of 12% solids to a high of 30% solids. The wet ton quantity includes both the sludge/biosolids residual liquid, as well as the actual solids. The dry ton quantity includes only the actual weight of the solids.

Table 3.30 Current WWTF Annual Sludge/Biosolids Production

Wastewater Facility	Sludge/Biosolids Produced (Wet Tons)		Concentration (% TS)	Sludge/Biosolids Produced (Dry Tons)	
	2006	2007		2006	2007
Dover, NH	3,450	3,450	20.0%(e)	690	690
Durham, NH	1,800	1,860	22.5%	400	420
Epping, NH (a)	0	0	-	0	0
Exeter, NH (a)	0	0	-	0	0
Farmington, NH	1,800	1,800	19.5%	350	350
Hampton, NH	3,200	2,700	23.0%	740	620
Newfields, NH	0	0	-	0	0
Newington, NH	440	250	12% (2006), 19% (2007)	55	50
Newmarket, NH	130	160	17.0%	20	30
Rochester, NH (a)	0	0	-	0	0
Rockingham Cnty, NH (a)	0	0	-	0	0
Rollinsford, NH (b)	0	0	-	0	0
Seabrook, NH	1,500	1,415	13.0%	225	210
Somersworth, NH (c)	2,200	2,400	19.0%	440	480
Berwick, ME	1,945	1,810	25.0%(f)	485	450
Kittery, ME	720	800	20.0%(e)	180	200
South Berwick, ME	2,600	2,600	23.0%	600	600
York, ME	1,340	1,480	12.0%	160	180
Pease WWTF	890	860	18.0%	160	155
Peirce Island WWTF (d)	2,515	2,815	30.0%	755	845
TOTALS:	**24,530**	**24,400**	-	**5,260**	**5,280**

a. Biosolids retained in lagoon system
b. Included in South Berwick, ME data
c. Estimated, data currently unavailable
d. Includes chemical sludge from CEPT system
e. Sludge concentration estimated from typical belt filter press performance
f. Sludge concentration estimated from typical centrifuge performance

3.8.2. Future Conditions

As presented herein, growth through the year 2030 must be considered to provide for a sustainable system. Project flows and loads for the City's WWTFs as well as specific WWTFs in the surrounding area have been developed. However, sludge and biosolids production is not only driven by an increase in flow or organic load. More stringent permit conditions will also increase WWTF sludge and biosolids production. For example, if a WWTF is required to reduce effluent nutrients, then biosolids production associated with the biological nutrient removal (BNR) processes will increase. Also, if a WWTF is required to utilize chemical precipitates to reduce pollutants, such as phosphorus, this will also increase sludge production.

3.8.2.1. Peirce Island WWTF

The largest increase in biosolids production will be associated with the Peirce Island WWTF, which will be converted from a primary to a secondary WWTF. In addition, it is assumed the WWTF will meet a future total nitrogen permit limit.

Sludge and biosolids generation projections at the Peirce Island WWTF have been developed based on the following:

- The highest TSS/BOD forecasts are utilized,
- Evaluations have been performed for the following two scenarios:
  - CEPT will either remain at the Peirce Island WWTF when converted to secondary treatment or will be applied to a new replacement secondary WWTF. Influent BOD will be reduced by 55% and TSS by 77% in the primary clarifiers.
  - CEPT will not be utilized, and influent BOD will be reduced by 30% and TSS by 50% in the primary clarifiers.
- Secondary biosolids will be generated at a rate of 1.5 lbs per pound of BOD applied to the secondary process, assuming that a high rate biological nutrient reduction (BNR) process is utilized..
- No reduction in volatile solids will occur.

In addition to sludge and biosolids loading, nitrogen loading associated with dewatered sludge has also been considered. Data specific to the Peirce Island WWTF for actual nitrogen levels in the dewatering filtrate is not available; therefore, text book values of 150 mg/l have been used for this evaluation.

Assuming that CEPT remains in use, biosolids and sludge yield will increase, as presented in Table 3.31. Should CEPT be discontinued, sludge and biosolids yield will increase as presented in Table 3.32. Should sludge be further dried from 30% solids to 90% solids, the total nitrogen load associated with the condensate will increase by approximately 5%.

Table 3.31 Sludge/Biosolids Production with CEPT

		Year						
		2007	2010	2020	2030	2040	2050	2060
BOD Load (wet)	(lbs/day)	6,812	7,335	7,971	8,572	8,971	9,263	9,292
TSS Load (wet)	(lbs/day)	6,004	7,128	7,740	8,323	8,715	9,006	9,035
Primary Sludge Generation (a)	(lbs/day)	4,630	5,497	5,969	6,418	6,721	6,945	6,967
Primary Effluent BOD (b)	(lbs/day)	3,065	3,301	3,587	3,857	4,037	4,168	4,181
Secondary Biosolids (c)	(lbs/day)	4,598	4,951	5,380	5,786	6,055	6,253	6,272
Total Sludge / Biosolids	(lbs/day)	**9,228**	**10,448**	**11,349**	**12,204**	**12,776**	**13,198**	**13,239**
Total Nitrogen Load (d)	(lbs/day)	**266**	**301**	**327**	**352**	**369**	**381**	**382**

(a) Based on 77% TSS reduction in primary clarifiers.
(b) Based on 55% BOD reduction in primary clarifier.
(c) Based on sludge yield of 1.5 lbs biosolids per pound BOD applied
(d) Based on thickening and dewatering to 30% solids and TN of 150 mg/l in filtrate.

Table 3.32 Sludge/Biosolids Production without CEPT

		Year						
		2007	2010	2020	2030	2040	2050	2060
BOD Load (wet)	(lbs/day)	6,812	7,335	7,971	8,572	8,971	9,263	9,292
TSS Load (wet)	(lbs/day)	6,004	7,128	7,740	8,323	8,715	9,006	9,035
Primary Sludge Generation (a)	(lbs/day)	3,002	3,564	3,870	4,162	4,358	4,503	4,518
Primary Effluent BOD (b)	(lbs/day)	4,768	5,135	5,580	6,000	6,280	6,484	6,504
Secondary Biosolids (c)	(lbs/day)	7,153	7,702	8,370	9,001	9,420	9,726	9,757
Total Sludge / Biosolids	(lbs/day)	**10,155**	**11,266**	**12,240**	**13,162**	**13,777**	**14,229**	**14,274**
Total Nitrogen Load (d)	(lbs/day)	**293**	**325**	**350**	**380**	**397**	**410**	**412**

(a) Based on 50% TSS reduction in primary clarifiers.
(b) Based on 30% BOD reduction in primary clarifier.
(c) Based on sludge yield of 1.5 lbs biosolids per pound BOD applied
(d) Based on thickening and dewatering to 30% solids and TN of 150 mg/l in filtrate.

3.8.2.2.Pease WWTF

The Pease WWTF operates as a secondary process with primary clarifiers. It is assumed that biosolids and sludge production will increase proportional to the increase in projected BOD.

In addition to sludge and biosolids loading, nitrogen loading to the Pease WWTF has also been considered.

The biosolids and nitrogen loading forecasts are presented in Table 3.33.

Table 3.33 Pease Sludge/Biosolids Production

		Year					
		2007	2010	2020	2030	2040	2050
BOD Load	(lbs/day)	2,340	2,546	3,233	3,920	3,920	3,920
% Increase over 2007			8.8%	38.2%	67.5%	67.5%	67.5%
Total Sludge / Biosolids	**(dry tons/yr)**	**160**	**174**	**221**	**268**	**268**	**268**
Total Nitrogen Load	**(lbs/day)**	**457**					

3.8.2.3.Regional WWTFs

To account for growth and the impact of more stringent discharge permit limits in the future, sludge and biosolids production at the regional facilities has been projected to increase by 50% in the year 2030. This factor is based on a 20% increase in biosolids yield due to increased BOD load associated with growth and a 30% increase in biosolids yield, assuming most regional WWTFs will implement BNR processes, resulting in higher biosolids yields.

Table 3.34 summarizes projected biosolids loads associated with Peirce Island WWTF, Pease WWTF and Regional WWTFs.

Table 3.34 Projected WWTF Sludge/Biosolids Production

Wastewater Facility	Sludge/Biosolids Produced (Annual Dry Tons)	
	2007	2030
Dover, NH	690	1,035
Durham, NH	420	630
Epping, NH [(a)]	0	0
Exeter, NH [(a)]	0	0
Farmington, NH	350	525
Hampton, NH	620	930
Newfields, NH	0	0
Newington, NH	50	75
Newmarket, NH	30	45
Rochester, NH [(a)]	0	0
Rockingham Cnty, NH [(a)]	0	0
Rollinsford, NH [(b)]	0	0
Seabrook, NH	210	315
Somersworth, NH [(c)]	480	720

Table 3.34 Projected WWTF Sludge/Biosolids Production

Wastewater Facility	Sludge/Biosolids Produced (Annual Dry Tons)	
	2007	2030
Berwick, ME	450	675
Kittery, ME	200	300
South Berwick, ME	600	900
York, ME	180	270
Pease WWTF	155	268
Peirce Island WWTF	845	1,760
TOTALS:	**5,280**	**8,448**

(a) Biosolids handled in lagoon system
(b) Included in South Berwick, ME data
(c) Estimated, data currently unavailable

Based on the above sludge/biosolids volumes, and assuming that sludge/biosolids would be brought to a regional facility the nitrogen component of the filtrate would reach an estimated 2,070 pounds per day in the year 2030, assuming 150 mg/l total nitrogen in the filtrate.

3.9. Septage Disposal Forecasting

Historic data utilized to develop septage disposal forecasting has been provided by the following sources:

- Operational data for the Pease WWTF, including septage receiving records, provided by the City.
- Data collected from phone surveys of the 16 New Hampshire and four Maine wastewater treatment facilities (WWTF) within the study area for 2006 and 2007.
- Data provided by the DES, which includes 2006 theoretical (estimated) septage and actual septage data for 2006 and 2007 within the study area.

Septage is generated when the septic tank of an on-site septic system is pumped and brought to a WWTF via private septic haulers. The City current only accepts septage at the Pease WWTF, and from non-sewered users in Portsmouth, and from Greenland, Newcastle and Rye.

In 2007, the City received approximately 1.6 million gallons of septage from these four communities. The New Hampshire Department of Environmental Services (DES) tracks septage disposal by town. In contrast, the four communities which disposed of septage at the Pease WWTF generated approximately 2.2 million gallons of septage in 2007, or 600,0000 gallons more than was disposed of at the Pease WWTF. This discrepancy is due in part to the fact that while the City only accepts septage from the four communities utilizing the service, the private septic hauler can dispose of septage at any WWTF willing to accept it. In recent years, the South

Berwick, Maine WWTF has positioned itself as a regional septage disposal facility, and by offering favorable disposal rates, received over 10 million gallons of septage in 2007, three (3) million gallons of which came from New Hampshire communities.

The NHDES currently has a grant program in place which provides for a 2% grant for each community with which a grantee formulates an agreement to accepts its septage, up to a maximum grant of 50%. The City is currently eligible for a 30% baseline grant, therefore, an additional 20% grant could be obtained for septage receiving and treatment, if the City were to seek formal agreements with 10 towns. The septage grant can be applied to all aspects of the WWTF affected by the receiving of septage, based on the following septage characteristics:

- BOD = 7,000 mg/L
- TSS = 15,000 mg/L
- NH3 -N = 150 mg/L

3.9.1. Septage Generation Scenarios

Five (5) septage generation scenarios for the planning of a potential septage receiving and handling facility have been evaluated. Each Scenario presents the current estimated annual septage volumes for municipalities within the seacoast study area as identified in TM-1. These volumes will be used as a baseline for septage generation and loading scenarios and will be adjusted based on the development projections presented in this memorandum for the planning period.

The data presented includes the estimated residential septage generation data for 2006 and actual reported data of residential/commercial septage for 2006 and 2007. This data was developed by the staff of NHDES as part of other ongoing state planning efforts. The estimated septage data generated by NHDES from each municipality was calculated using the number of households with septic systems within the municipality and assuming the average 1,000 gallon tank is pumped every 5 years. The information was based on planning level details for the number of households and population data from the State Office of Energy and Planning (OEP). The estimated septage represents only domestic generated septage (residential) and is only included as a comparison to the actual reported septage quantities.

The actual reported septage generated from each municipality was compiled from reports submitted by the regional septage haulers licensed to pump, haul, and dispose of septage. Based on input from NHDES staff, it is believed that this data more accurately reflects the total amount of septage generated from each municipality. It should be noted that, in general, the septage volumes reported during 2007 decreased from 2006. There are several factors responsible for the decrease in septage during 2007, including the slow down in the economy which may have discouraged people from pumping septage as often as recommended, and some of the 2007 data may not have been received by the NHDES at the time we were provided the data. In general the 2007 and 2006 actual reported septage volumes are consistent. In addition, these actual volumes are reasonably consistent with respect to the residential generation estimates developed by NHDES for those communities that are non-commercially intensive.

The following scenarios have been developed based on the highest value of 2006 or 2007.

3.9.1.1.Scenario A – Septage Generated from Portsmouth

Scenario A presents septage data only from the City of Portsmouth. The annual septage generation quantity for Scenario A is 921,000 gallons.

3.9.1.2.Scenario B – Septage Generated from Local Seacoast Municipalities

This scenario presents septage data from the City of Portsmouth and the six (6) local municipalities surrounding Portsmouth. These municipalities were identified in TM-1 and include Greenland, Newcastle, Newington, North Hampton, Rye, and Stratham. The City already receives septage from Greenland, Newcastle and Rye. The annual septage generation for Scenario B is 4,133,000 gallons

3.9.1.3.Scenario C – Septage Generated from Local Seacoast Municipalities to Achieve Maximum Funding

This scenario presents septage data from the City of Portsmouth, including the six (6) local municipalities identified in TM-1, and additional municipalities to achieve the maximum amount of state funding to construct the septage receiving facility.

In addition to the six (6) municipalities identified in Scenario B, four (4) additional municipalities were added to increase the amount of potential funding assistance to the maximum of 50%. Portsmouth currently is eligible for a base 30% grant for wastewater related facilities. Therefore, with the ten (10) additional communities identified, Portsmouth could reach the 50% grant maximum (30% base + 2%x10 = 50%).

The additional four (4) municipalities selected are Hampton Falls, Kensington, Lee, and Madbury. These towns were selected on the basis that they do not currently have a municipal WWTP and the proximity to Portsmouth. No other factors were considered in the selection of these municipalities including political or economic factors at this time.

The annual septage generation for Scenario C is 4,955,000 gallons.

3.9.1.4.Scenario D – Septage Generated from all Study Area Municipalities w/out WWTFs

This scenario presents septage data from the City of Portsmouth, including all the study area municipalities without wastewater treatment facilities. Including Portsmouth this Scenario includes 30 municipalities.

The annual septage generation for Scenario D is 15,046,000 gallons.

3.9.1.5.Scenario E – Septage Generated from all Study Area Municipalities

This scenario presents septage data from the City of Portsmouth and all of the study area municipalities. Including Portsmouth this Scenario includes 44 municipalities.

The annual septage generation for Scenario E is 20,899,000 gallons.

3.9.2. Septage Receiving Needs

Based on historic data for septage receiving at the Pease WWTF, the annual distributing of septage is as follows:

Month	% of Total Septage Received
Jan	7%
Feb	7%
Mar	7%
Apr	8%
May	8%
Jun	10%
Jul	9%
Aug	10%
Sep	11%
Oct	11%
Nov	5%
Dec	6%

During the months of September and October the highest volume of septage is received at the Pease WWTF. Assuming this trend continues in the future, the septage receiving capacity for a regional septage facility is presented in Table 3.19, based on 3,000 gallon septage trucks.

A single commercially available septage receiving system can operate at 400 gallons per minute (gpm) maximum, and at a recommended rate of 200 gpm. In addition, time must be allowed for the truck operator to connect and disconnect the truck, wash down, and perform administrative tasks for billing. In general, an allowance of 20 minutes for a 3,000 gallon septage truck is an acceptable timeframe from facility entrance to exit.

With the time frames projected in Table 3.35, a single commercial septage receiving system, operating 14 hours per day would meet the needs of all scenarios.

Table 3.35 Septage Receiving Capacity Requirements

	Septage Gallons				
Scenario	Projected Annual	Peak Month	Per Day	Trucks per Day	Discharge Time Required (hrs)
A	921,000	101,310	5,065	2	0.6
B	4,133,000	454,630	22,730	8	2.6
C	4,955,000	545,050	27,250	10	3.1
D	15,046,000	1,655,060	82,750	28	9.2
E	20,899,000	2,298,890	114,940	38	12.8

The nutrient impact of septage receiving, assuming that the septage is treated as a biosolid, in that the material is dewatered and only the filtrate is introduced to the biological process, is summarized in Table 3.36.

Table 3.36 Septage Contribution to Total Nitrogen Loading

	Total Nitrogen Load		
Scenario	Dewatered Filtrate (lbs/day)	Drier Condensate (lbs/day)	Total (lbs/day)
A	1,142	152	1,294
B	5,126	684	5,810
C	6,146	819	6,965
D	18,663	2,488	21,151
E	25,923	3,456	29,379

3.10. Fats, Oils and Grease

NH FOG Study & Generation

In 2006 the New Hampshire Legislature passed HB 1373 which established a "Commission" to study fats, oils, and greases (FOG) generation and to recommend best management practices for FOGs. The Commission was comprised of various entities within the State of NH including representatives from the state government (Speaker of the House and Senate President), Department of Environmental Services (NHDES), NH Association of Septage Haulers, NH Lodging and Restaurant Association, NH Water Pollution Control Association, and the University of New Hampshire.

FOG is commonly derived from food products such as deep-fried foods, meats, sauces, gravy, dressings, baked goods, cheeses, and butter. Food-derived FOG can end up going down the drain and ultimately into the sewer system during the cleaning of plates, pots and pans to remove food residue or by improper disposal of leftovers or grease. Once inside the sewer FOG can form a thick layer on the inside of pipes blocking sewage from traveling through the sewer pipe.

Weston & Sampson has reviewed this report and is basing its FOG generation rates from the data provided within the report. The Report titled *Commission to Study Ways to Encourage Proper Recycling and Disposal of Grease Trap Wastes and to Develop Additional Disposal Capacity* was finalized November 1, 2007.

The commission was conducted to study and provided recommendations on the handling of wastewater greases. The report cites a grease generation rate from *Urban Waste Grease Resource Assessment*, published by the US Department of Energy (1998). According to this report, the "combined resources of collected grease trap waste and uncollected grease entering the sewage treatment plants **ranged from about 2 to 27 pounds/person/year**" and the weighted **average of grease trap waste is approximately 13.4 pounds of grease/person/year** (Wiltsee, 1998). The report states that data collected and used to determine these estimates of grease trap generation rates are subject to inherent inaccuracies because the material can contain a significant amount of water and other wastes when collected. A grease content of 10% by weight was used for grease trap waste in estimates generated for the Boston area. A range of 20 to 50 ppm (mg/L) was determined for the concentrations of oil and grease measured in raw wastewater received at WWTPs from the 30 metropolitan areas studied in the USDOE report.

The commission then estimated the NH grease or FOG generation based on the 2006 state population. The following figure is from the Commission's report.

Estimated Grease Generation in NH

2006 NH Population **1,314,895** x **13.4** pounds of grease/person/year = **17,619,593** pounds/year

Convert to Gallons

17,619,593 Pounds of grease/year ÷ **8.34** pounds/gallon = **2,112,661** gallons/year

Source: Commission to Study Ways to Encourage Proper Recycling and Disposal of Grease Trap Wastes and to Develop Additional Disposal Capacity, November 1, 2007

The commission's report stated that the estimated 2.1 million gallons per year is probably a conservatively low figure because New Hampshire has a seasonally high tourist population that increases the actual grease generation rates. This is even more evident for Portsmouth, which has a higher than average restaurant density and tourist population. However the Commission felt that the annual value was appropriate for planning purposes.

FOG Disposal

The Commission also compiled FOG disposal data for New Hampshire. Unfortunately, data is not readily available for NH disposal and currently detailed recordkeeping is non-existent. Therefore, to estimate FOG disposal in New Hampshire, all known disposal outlets in the New England region were contacted through a phone survey in the summer of 2007. As with any survey, the results may have a wide range of accuracy. The survey results which come directly from the Commission's Report are presented below.

NH Grease Disposal in 2006

Disposal Location		Quantity (Gallons)
Baker Commodities Inc. (Corenco)	Billerica, MA	100,000
EarthSource Wastewater Facility	Raynham, MA	225,000
Merrimack WWTF	Merrimack, NH	166,422
Milford Wastewater Treatment Facility	Milford, NH	6,000
Northeast Environmental Processing	Lawrence, MA	47,460
Pat Jackson, Inc./Tri-City Septic	Augusta, ME	10,000
Suburban Contract Cleaning, Inc	Rochester, MA	125,000
South Berwick (ME) WWTF	South Berwick, ME	439,067

Disposal Location		Quantity (Gallons)
Stewart Septic Service, Inc.	Bradford, MA	745,900
Suncook Wastewater Treatment Facility	Allenstown, NH	582,150
	Total:	**2,446,999**

Source: Commission to Study Ways to Encourage Proper Recycling and Disposal of Grease Trap Wastes and to Develop Additional Disposal Capacity, November 1, 2007

In 2006, the commission reported that grease generated in New Hampshire went to 10 disposal locations throughout the region. A total of 2.4 million gallons was disposed from NH during 2006. For comparison, the number of gallons disposed (2.4 million) is relatively similar to the estimated average number of gallons of FOG generated (2.1 million). This is important because it provides some validation for the use of the generation rates numbers when evaluating the Seacoast area for FOG generation.

Seacoast Area FOG Generation

Because actual FOG generation data is difficult to gather and compile, it is proposed to use the generation rates provided in the Commission's Report for the purpose of this Master Plan. The following assumptions were considered during the calculation of Seacoast Area FOGs.

- FOG Generation rate range shall be 2 to 27 lbs/person/yr. The average is a straight average based on the low and high generations.
- The average of the low and high generation shall be used for the Seacoast Area with the exception of Portsmouth which use the maximum generation rate due to its high tourist population.

NH FOG Generation

Study Area	Population	FOG Generation Rates (lbs/person/yr)(1)		Estimated FOG Generated (gal/yr)(2)		
		Low	High	Low	High	Average
State of NH	1,314,895	2	27	315,323	4,256,854	2,286,088
Portsmouth	20,995	2	27	5,035	67,969	36,502
Seacoast w/out Portsmouth	273,968	2	27	65,700	886,947	476,323
Seacoast including Portsmouth	294,963	2	27	70,735	954,916	512,825

Notes: The population data for entire state of NH is from the 2006 census, the populations for the Seacoast and Portsmouth is from 2005.

(1) FOG generation rates assume a grease content in pumped grease trap waste of 10% by weight and an oil and grease concentration in raw wastewater of 20 to 500 ppm (mg/L).

(2) Calculations assume the density of FOG to be equal to water (8.34 lbs/gal).

Weston & Sampson recommends the following annual FOG range of loading for the Seacoast Area Municipalities.

- **Portsmouth: <u>68,000 gal/yr</u> FOG Generated** (Portsmouth high rate)
- **All Seacoast Municipalities: <u>545,000 gal/yr</u> FOG Generated**
(Seacoast average + Portsmouth high)

<u>References:</u>

State of NH (November 1, 2007), *Commission to Study Ways to Encourage Proper Recycling and Disposal of Grease Trap Wastes and to Develop Additional Disposal Capacity*
NH Office of Energy and Planning, 2005 population data

Urban Waste Grease Resource Assessment, published by the US Department of Energy (1998)

3.11. Summary

Tables 3.37 and 3.38 summarize the current and projected flows and loads for the Peirce Island, Pease WWTF, as well as the study area. Note that these numbers are indicative of the potential future capacities of existing and new WWTFs, and may change as additional information becomes available.

Table 3.37 Current Conditions Summary

Population [(a)]	20,811
Employment [(a)]	28,768
Peirce Island WWTF Flows and Loads	
Sanitary Flow, mgd [(b)]	2.60
Total Wet Weather Flow, mgd [(c)]	8.75
BOD, lbs/d [(d)]	6,812
TSS, lbs/d [(d)]	6,004
TN, lbs/d [(d)]	3,000
Sludge Yield, lbs/d [(e)]	4,630
Pease WWTF Flows and Loads	
Sanitary Flow [(d)] mgd	0.41
Wet Weather Flow [(d)(f)] mgd	0.59
BOD, lbs/d [(d)]	2,137
TSS, lbs/d [(d)]	2,337
Sludge/Biosolids Yield, lbs/d	2,340
TN, lbs/d	347

(a) Source: New Hampshire Office of Energy and Planning
(b) Includes all tributary sanitary flows
(c) Does not include CSO flows
(d) Based on 2007 data, includes septage
(e) Includes chemical sludge
(f) Includes sanitary flow and I/I

Table 3.38 Future Conditions Summary

	Year					
	2010	2020	2030	2040	2050	2060
Population	21,320 (a)	22,730 (a)	24,390 (a)	25,881 (b)	27,373 (b)	27,450 (b)
Employment	29,919 (c)	32,796 (c)	35,672 (c)	38,549 (c)	41,426 (c)	44,239 (c)
Peirce Island WWTF Flows and Loads						
Sanitary Flow (d) mgd	2.68	3.14	3.49	3.65	3.80	3.86
Wet Weather Flow (e) mgd	6.27	6.27	6.27	6.27	6.27	6.27
Total Flow, mgd	8.95	9.41	9.76	9.92	10.07	10.13
BOD, lbs/d (f)	7,266	7,758	8,223	8,647	9,072	9,234
TSS, lbs/d (f)	7,064	7,542	7,998	8,413	8,828	8,981
TN, lbs/d (f)	3,230	3,510	3,775	3,950	4,080	4,090
Sludge/Biosolids Yield, lbs/d (g)	10,448	11,349	12,204	12,776	13,198	13,239
Pease WWTF Flows and Loads						
Sanitary Flow (d) mgd	0.47	0.68	0.88	1.09	1.30	1.51
Wet Weather Flow (h) mgd	0.53	0.53	0.53	0.53	0.53	0.53
Total Flow, mgd	1.00	1.21	1.41	1.62	1.83	2.04
BOD, lbs/d (f)	2,340	2,675	3,009	3,343	3,676	4,010
TSS, lbs/d (f)	2,314	2,645	2,975	3,305	3,635	3,965
TN, lbs/d						
Sludge/Biosolids Yield, dry ton/yr (i)	160	174	221	268	268	268
Regional WWTFs						
Sludge/Biosolids Yield, dry ton/yr (i)(j)	-	-	6,420	-	-	-
Including Peirce Island and Pease WWTFs			7,356			
Septage						
Annual (1,000 Gallons) (k)	4,133					

(a) Source: New Hampshire Office of Energy and Planning
(b) Assumes the average growth rate of the New Hampshire Office of Energy and Planning forecasts continues beyond 2030 until reaching the buildout population of 27,450 (see Section 3.5) in the year 2051.
(c) Medium growth employment forecast: 1.0% annual growth rate. Employment reaches buildout level of 44,239 in the year 2054
(d) Based on medium employment growth rate. Includes all tributary sanitary flows.
(e) 10 – Year maximum month, medium employment growth, does not include CSO flows
(f) Based on medium employment growth.
(g) Assumes CEPT is utilized, based on secondary biosolids yield of 1.5 lbs/lb BOD
(h) 10 – Year maximum month, medium employment growth
(i) Assumes sludge/biosolids yield increases with influent BOD
(j) Does not include Pease or Peirce Island WWTFs
(k) Scenario B, Septage currently generated from local seacoast communities.